ATTACHMENT H

Table, Waters of the Bad River Reservation

Bad River Reservation Waters

WATER BODIES	Importance to Tribe						
	Cultural	Wildlife	Wild Rice	Aquatic Life	Recreation	Cold fishery	Cool fishery
Kakagon Slough	X	X	X	X	X		X
Sand Cut Slough	X	X	X	X	X		X
Bad River Slough	X	X	X	X	X		X
Honest John Lake	X	X		X	X		X
Wood Creek Slough	X	X	X	X	X		X
Bad River	X	X	X	X	X	X	X
White River	X	X		X	X		X
Marengo River	X	X		X	X	X	
Potato River	X	X		X	X	X	
Wood Creek	X	X		X	X		
Bear Trap Creek	X	X	X	X	X		X
Graveyard Creek	X	X		X	X	X	
Bell Creek	X	X		X	X	X	
Morrison Creek	X	X		X	X	X	
Newago Creek	X	X		X	X	X	
Denomie Creek	X	X		X	X		
West Branch Denomie Creek	X	X		X	X		
Rins Creek	X	X		X	X		
Silver Creek	X	X		X	X	X	
Thornapple Creek	X	X		X	X		
Meadow Creek	X	X		X	X		
Elm Creek	X	X		X	X		
Vaughn Creek	X	X		X	X		X
UpperVaughnCreek	X	X		X	X		X
Winks Creek	X	X		X	X		X
Cameron Creek	X	X		X	X		X
Sugarbush Creek	X	X		X	X		
Hanson Swamp	X	X		X	X		
Sugarbush Pond	X	X		X	X		
Alex Pond	X	X		X	X		
Wolf Pond	X	X		X	X		
Pictured Rock Lake	X	X		X	X		
Sugarbush Lake	X	X		X	X		
Lost Lake	X	X		X	X		
Moonshine Lake	X	X		X	X		
Bog Lake	X	X		X	X		

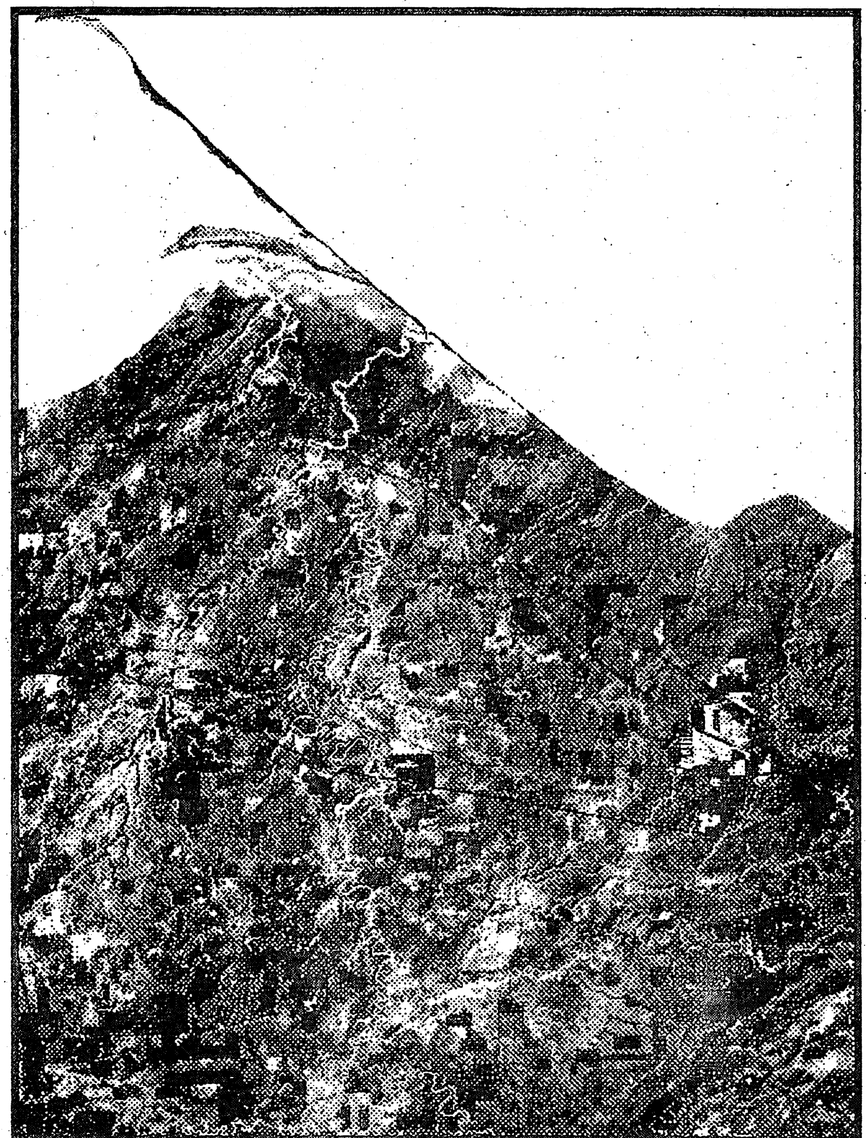
* Un-named waters not listed above have the following importance to the Tribe: Wildlife habitat, Aquatic Life and Fish Habitat, Recreation.

ATTACHMENT I

Water Resources of the Bad River Reservation. Water Resources Management Workshop, Institute for Environmental Studies, University of Wisconsin-Madison. Spring/Summer 1994. 155 pages.

Section on Historical and Cultural Perspectives of Elders

Water Resources of the Bad River Reservation



Water Resources Management Workshop ♦ Spring/Summer 1994
Institute for Environmental Studies ♦ University of Wisconsin–Madison

FIGURES

TABLES

PLATES (AFTER PAGE 104)

Executive Summary

In cooperation with the Bad River Band and The Nature Conservancy, the Water Resources Management Practicum (WRM workshop) of the University of Wisconsin–Madison spent the spring and summer months of 1994 formulating a water-resources assessment of the Bad River Reservation. The WRM workshop members were graduate students whose individual interests ranged from engineering to natural and social sciences to law and planning. Our workshop project was one of several elements of the Bad River Band's ongoing natural resources management efforts; therefore, we worked on the project in cooperation with the Bad River Natural Resources Department.

Over the course of the spring semester, we collaborated with the Bad River Natural Resources Department to develop a work plan for the project. On the basis of that work plan, we provided several types of assistance.

Workshop Products

Newsletter

An eight-page newsletter introduced reservation members to the Integrated Resources Management Planning process, which is currently being organized by the Bad River Natural Resources Department. We provided a template and printing guidelines for future newsletters.

Legal memoranda

We drafted three legal memoranda on issues of specific interest to tribal members. One memorandum outlined guidelines for assessing the tribe's authority to zone. A second memorandum reviewed a Federal Circuit Court's decision in *Blue Legs v. United States Bureau of Indian Affairs*, 867 F.2d 1094 (8th Cir. 1989). In addition, we provided the tribe with a description of the process by which the tribe may be treated as a state for purposes of administering water-quality standards under the Clean Water Act.

Consulting

Concurrent with our workshop, the Bad River Natural Resources Department was developing a water-quality laboratory. We assisted the tribe with this project, advising them on purchasing and set-up decisions. We created two laboratory manuals: (1) a manual on standard operating procedures, and (2) a manual addressing issues of quality assurance and quality control. Other products of the workshop were a geographic information system document and maps. We also advised tribal members about resource-related issues. For instance, we researched the availability of video productions pertaining to watershed management.

General report

Much of the workshop effort was directed at creating the general report on the water resources of the Bad River Reservation. We realized the importance of understanding the area's history as well as the cultural significance of its water resources; therefore, the first part of the general report consists of interviews that we conducted with several tribal elders over the course of the summer on subjects related to the reservation's water.

We then review the history and current interpretation of Native American Sovereignty and of the Federal Trust Responsibility. We describe the federal court rules for treaty interpretation as well as several applications of federal powers in Indian Country. A tribe's criminal and civil jurisdiction over reservation members and nonmembers alike is also discussed.

In the next part of the report, we review the general characteristics of the reservation's water resources, focusing on those physical characteristics of an area that are important to watershed management—climate, topography, hydrogeology, surface water, soils, vegetation and land cover, wetlands, land use, and water quality. Recommendations discussed in this section include the following:

- Minimize land uses that could lead to the release of contaminants that might threaten groundwater. This is particularly important in the southern part of the reservation, including the wastewater-treatment lagoons at Birch Hill.
- Improve mapping of the southern extent of the Miller Creek aquitard. The southern part of the reservation is more sensitive to groundwater contamination than the northern part because the southern part is the probable recharge area for the reservation's drinking water.

After this general review of reservation resources, we focused on Denomie Creek watershed to provide a complete watershed assessment as a model for future research. This assessment involved an initial analysis and description of the basin's physical environment. In addition to the general reservation recommendations above, in this section of the report we recommend that the Bad River Band identify the sources and sinks of phosphorus within the Denomie Creek watershed; this concern is motivated by the scarcity of data rather than an observed problem.

A second step in the assessment was identification of point and nonpoint sources of pollution to Denomie Creek. Point sources addressed are septic tanks, sewage lagoons, underground storage tanks, and abandoned wells. Our recommendations include the following:

- Avoid the use of septic systems whenever possible.
- Where septic systems exist, maintain them properly on a regular schedule.
- Make an inventory of all septic systems and a record of any past failures.
- Inspect all underground storage tanks and determine whether to close and replace the tanks or to install required protections. In general, removal

of all nonconforming tanks is suggested (U.S. EPA assistance may be available for this).

• Monitor state and federal enforcement actions against non-Indian underground storage tanks on the reservation through public information requests to the Wisconsin DNR and the U.S. EPA.

Nonpoint pollution sources include utility corridors, forestry practices, and stormwater runoff. The unstable red clay soils on the reservation led to the following recommendations:

• Ensure that all forest-management activities are conducted using best management practices to protect vulnerable soils in the watershed.

• Extend riparian management zones with no cutting at least 100 ft landward of the ordinary high water mark. Ideally, this would apply to all private land as well.

• Do not clearcut or thin trees on the steep slopes leading down to the creeks and rivers on the reservation.

• Use managed timber harvests instead of clearcuts; focus on aspen removal, and leave a variety of seed trees for forest regeneration.

• Continue collecting data on the forestry practices of the major industrial landowners on the reservation.

• Monitor timber harvests on alienated land through remote sensing data and field reconnaissance and add data to the tribal geographic information system. Extend this database back over the past 15 years.

Additional recommendations include the following:

• Minimize the use of excessive road salt and sand in favor of deicers such as calcium magnesium acetate and CG-90.

• Collect waste oil, toxic household wastes, and solid waste material for proper disposal.

Finally, we provide a monitoring program for Denomie Creek. Baseline water-quality data can be used to classify water bodies for specific uses, to help set water-quality criteria for given uses, and to perform wasteload allocations for issuing discharge permits. The program involves determining and establishing monitoring locations, which are chosen after pertinent criteria are researched and each area's susceptibility to degradation is evaluated. We recommend several water-quality parameters to monitor, sampling schedules, and analytical techniques.

This report also includes a glossary of water-quality terms and three appendixes. Appendix A provides guidelines for using legal resources and Appendix C presents selected water-quality data collected by diverse parties for surface water and groundwater on the reservation.

Historical and Cultural Perspectives from Tribal Elders

It is good that in spite of all the changes that modern life has brought to Indian people, that there are those who keep strong the gifts of yesterday. For it is with yesterday that we learn for tomorrow.

Edward Benton-Benai,
The Mishomis Book:
The Voice of the Ojibway

No discussion of the water resources on the Bad River Reservation would be complete without a perspective on how things have changed over time and what role water resources play for the Ojibway people. When we traveled to the reservation for the first time, we saw a lush and relatively pristine environment, well protected from the development occurring in the Lake Superior region. We knew that in addition to conducting our project with the tribe, we had a great deal to learn from the Ojibway culture and way of life.

We decided early in the project to interview tribal elders to obtain a historical and cultural perspective on the reservation's resources. In Native American cultures, elders are respected and honored for their knowledge and wisdom. Despite the name, elders are not necessarily the oldest members of the tribe—they are those who carry a deep knowledge of the Ojibway culture and have witnessed many changes in their lifetimes, including changes to natural resources.

We interviewed four tribal elders: Cecilia Mix, Eugene Bigboy, Sam Livingston and Bob Powless. Their views do not necessarily represent the views of all tribal elders, but their stories and comments show the importance of natural resources to the tribe and how the reservation's resources have changed over time.

Cecilia Mix, 94, is the second eldest tribal member. She still speaks the Ojibway language. Eugene Bigboy, 58, was on the tribal council for 18 years, nine years as tribal chair. Today, he is the principal at a school on the Lac Courte Oreilles Reservation (grades K–12). Sam Livingston, 62, served as tribal chair for three terms. Robert (Bob) Powless, 66, studied anthropology at the University of Wisconsin.

We approached the elder interviews as "listening sessions." Although we had a list of questions, we allowed conversation to flow naturally, depending on areas of interest to the elder. We asked many questions about natural resources. We also asked specific questions about Denomie Creek because we were conducting a watershed assessment and creating a monitoring plan for the watershed. Our questions included the following:

- Can you describe the importance of water to the people living on the reservation?
- Can you tell us how the tribe discovered the wild rice and the sloughs?

- What are your strong memories of the sloughs and wild rice?
- Do you think wild rice abundance has changed in the Kakagon Slough?
- Do you remember a time when people harvested rice in the Bad River Slough or Honest John Lake?
- Do you remember anyone catching fish or swimming in Denomie Creek?
- Does anybody use Denomie Creek for anything today?
- In your lifetime, how have you seen the natural resources change on the reservation?
- Do you have concerns about any of the natural resources on the reservation?
- Do you think there are certain areas of the reservation where water-quality testing should be done?
- Do you have concerns about how tribal members treat the natural resources?
- Do you feel the tribe has managed the resources well?

By taping the conversations, we were able to relate the elders' stories and opinions exactly as they were told to us. We wanted to capture not only the essence of what the elders were saying, but the precise wording, so each reader could gain his or her own insight into the tribal culture, experiences and opinions. To provide clarity, however, we did shorten some responses and rearrange the order of questions, grouping the responses when the same question was asked to more than one elder.

We are grateful to the elders for so eagerly sharing their experiences with us. We are also grateful to Joe Rose, Sr., Bad River tribal member and director of Native American Studies at Northland College, for helping to coordinate the interviews. He identified tribal elders, explained our project to them, and helped set up the interviews. He also prepared us for the interviews by sharing his knowledge of the Ojibway culture.

Through the interviews, we learned a great deal about the tribe, the culture, and the natural resources on the reservation. We hope to share some of the knowledge we gained on the following pages and throughout the rest of the report.

Importance of Water Resources to the Tribe

Can you describe the importance of water to the people living on the reservation?

Bob Powless: "Well, it's a way of life for them. They settled here because of that water, the river. They must have drunk out of it. In fact, when they made the first village they must have used that for drinking water [points to Bad River]. . . . And people being who they are, the ability to make decisions about their life, picked something or a place where they could survive, where there was water, what we needed most—water. So that's what they must have done.

"There must have been a portage in there at one time, before they built that old highway here, across over to Kakagon. Or maybe it was flooded even most of the time. This was the main water route to south from here, both rivers—the White River and the Bad.

"And then of course in 1887 they passed the Allotment Act and it was ratified in 1889 and then they started allotting land under that act—40 acres to single adults, probably 80 acres to a married couple, a man with a family. And that allowed the Bureau of Indian Affairs then to act as an intermediary, to put that land, or that timber up for sale, and began that declination of what was good here. This all used to be timber here, right here where we are right now. . . . Old Bill Knight was telling me that when he was a kid the white pines were so big and thick and heavy in this area around here. And there's nothing now.

"Well, it supported everything, that river—the fish, the wildlife, the animals. And it did the same for us as we came along."

Kakagon Slough And Wild Rice

Can you tell us how the tribe discovered the wild rice and the sloughs?

Sam Livingston: "If you've heard it a thousand times, you've heard it once. It comes from when we migrated down here, we were told to stop here at the rice fields. This is the Ojibway legend. This is where we were told to stop. We came from the East Coast all the way down here. And we were to go as far to a place where we would know it when we came. There would be some shells and the wild rice would be plentiful for the entire tribe, the entire band. That would be part of Minnesota, Wisconsin, and Michigan, all bordering Lake Superior, Canada also. But that's about the nearest I can get."

Bob Powless: "They found a place here with that wild rice. They must have had experience with it before they got this far. They found that big slough out there. There's a question whether they came here in the 1600s or whether they were here before that. There's a question about that. But anthropologists and people who document these things tend to go by whatever they can date.

"The name for this place that we get, the oldest one that I get, I just found out a different name yesterday that this place might have been called. It might have been called 'Waters Meet' at one time. There's one in Michigan, about an hour and a half from here—the waters meet. But this might have been because there's two rivers right here. That used to be an island, there's a bridge here, but that used to be an island right there, between these two rivers—the White River and the Bad River.

"The Indian name that I know translates to the 'old garden.' That would be down here [he points past the church]. It is good soil to plant. And then water. The water must have been pure enough to drink. There's no springs that I know of around here, unless there's one over here that could have been, but no, I don't think so. No. They wouldn't have been that far, they would have been right on top of it, as far as that water. Right over on this street over here, about half way down, there's a house trailer there now, but we used to live over there. There was a box on the edge of the sidewalk where I had this big—it would come so high like that [he shows]—that had running water. That was kind of community water. But the earlier Indians must have drunk water. They must have gotten it out of here. There were many people that were here."

What importance do the sloughs have to the tribe and to you?

Eugene Bigboy: "I honestly think that being a member of this band here, the sloughs are very important to us, it's kind of part of our lifestyle, part of our living. And to a lot of people it's part of their life, getting along. A lot of people nowadays are making a lot of money on rice. They go down there and rice. I don't do that myself, but there are people that do. And I could see it being important that way too. To me, it's more important just being there and knowing it's there. It's sort of part of me just like my hand is part of me. It's there if I need it. If I don't feel I need it, then I don't bother with it. But it's a good feeling to know it's there and it's yours."

What are your strong memories of the sloughs and wild rice on the reservation?

Sam Livingston: "My grandmother and my mother and all her family had a cabin, an old shack down on Wood Creek, which was our ricing headquarters. It was kind of an annual thing to go up. Age didn't make any difference. Even if you were four years old, you were out there. If you were ten years old, you were out there. If you were just a newborn baby, you were out there.

"What I recollect about the sloughs is that the water was clear, crystal clear, and very few motor boats. People used paddles or oars to row down and occasionally when supplies had to be moved there was an older guy that had a motor that would pull people up and down the rivers to get down. He was helping people move to their rice camps.

"Again, the water was crystal clear, we drank it, we used it for cooking. It was my chore after I got a little older to go out to Wood Creek to push past the weeds into the middle of the river and fill up pails of water. And I could drink from it, I could reach down and drink from it using my hands. And it was clear. No one was afraid of contamination like we know about today.

"Ricing would sustain us two years. It was a planned effort. They had a system then. They would tie the stocks together, much like we do today. Then they wouldn't touch that rice until the older people tested the rice. They hit it with their hands and if the rice fell off, and they did that up and down river to the sloughs, then they would start ricing.

"It was nothing to have a boat go to rice in the morning, and a boat go to ricing in the afternoon. And it was commonplace to leave, after ricing season was over, with four or five hundred pounds of clean wild rice. There was nothing to it.

"The process of cleaning was done right at the selected site, though. And rice was in abundance then. It was managed properly by the elders. There was no chopping the green, knocking the stems down or anything like it is done today. People today really don't care about reservation or conserving or anything like that. When they feel that it's ricing time, they go out whether it's ripe or green.

"But I think the biggest influence was that, again, it was organized and people had control of that—not because there was a law but because it was their idea of preserving that. Because every year they had it. The rice would sustain them through the hard time, through the rest of the year. And they also gave it to other people. There were relatives mainly, and people who were in need.

"And not only that, at that particular time there were an abundance of ducks and things down there, waterfowl. It was nothing to see a variety of teals (blue-winged and green-winged), mallards (a variety of mallards), coots. It was just commonplace to see them. There also were deer, bear, fish—walleye, northern pike, pickerels.

"Everybody had to pull their own weight in a sense, even the kids, even the young kids. My job at one time (like I said) was to haul water. . . . That was my job. I went out and got the water and brought it back. . . .

"It was an adventure, too. A lot of time other people would get up and leave the camp and I was the only one there because I happened to be the youngest. I would get up on the top of the roof of the house and try to spot them where they were ricing. . . . I also had a function while I was doing that. I had to wash the dishes and get a fire going when I saw them coming, and be functional in that whole system. They taught me to do this. They took the time."

Were you involved with wild ricing as a kid?

Bob Powless: "Yah. Well, incidentally there's kind of a little story they tell about me, about wild ricing, or ricing, they call it ricing. Camping down through the sloughs down there. I grew up in a cradle board. They used to put me in a cradle board when I was a baby. That technology, that part of the culture was still alive yet. And so they used to hang me in a tree down there, by the wild ricing. That was a long time ago."

Do you remember when you were older, going out ricing?

Bob Powless: "When I was a kid I went down there a couple times. And I didn't get too much. My main job was what we call 'dancing' that rice. We didn't have that modern technology then, of winnowing that rice. So they'd say, 'Get in the barrel, Bobby. You're the one that's going to do that to the rice.' So that's what I did.

"I remember my grandmother and old relatives coming down there, old Joe had a place down there. I remember them coming down with rice in the evening and their boat had maybe about an inch of freeboard. That rice was just piled in there from one end to the other. There was a couple hundred pounds, maybe more, of that green rice in that boat. There was just two of them that day. They were old people at that time. And so to process that rice they would kind of dry it out like this, spread it out, and then scorch it by hand, and then dance that rice, and then winnow it and everything like that. It was kind of a family affair. Everybody got into it."

Do you go out ricing anymore?

Bob Powless: "Yah. I haven't in the last couple years. I haven't been out there. But I taught my kids to do that. I took them out, I started with them, my boys. I have four boys. I started when they were nine or ten years old, ricing. All of them, one at a time of course. But I started when they were all like that [he shows the height with his hands].

"I started hunting with them, same thing, nine or ten years old. I gave them guns at that time. In fact, I used to have maybe 12 or 15 of those young people out there. I taught them to hunt, to get them off on their own. I enjoyed it."

Do you have a certain philosophy about hunting that you shared with them?

Bob Powless: "Yah. If you shoot something, find it, chase it if you have to. Go back the next day if you have to. Chase it again. But find it if at all possible. Don't waste it. Don't waste anything. Same thing with rice. Don't waste it. It's too hard of work. People think that's sport. But to us it's a way of survival. And it's work. That's what I taught about hunting and ricing and fishing and everything like that—it's work. Don't waste it."

Do you think the wild rice abundance has changed in the Kakagon Slough?

Bob Powless: "Yah, I think so. I talked before about being crowded out by different species and one of those things was that purple loosestrife. That is kind of a recent thing, but still. Something else, I think they call it a 'buffalo leaf,' that's a common name for that, it's like a lily pad. That takes over. There's been some effort to clear that out down there too, but that spreads real fast and it's taking over those rice fields."

Eugene Bigboy: "Again, that depends on your weather. If you get the right kind of weather for rice, you'll get a lot of it. If you get the wrong kind of weather for rice, then it's going to be pretty sparse. I would think 20 years ago we had more rice, just like fish and everything else. Back when I was young, which was quite a few years ago, it was no problem to go down to the lake and net ten tubs of walleye in three or four hours. Now you go down there and you have a dickens of a time catching ten walleye. I guess it's getting a lot better, but I remember 40 years ago, I was 18 years old, I used to go down there and catch fish for the whole reservation—all the sisters and nuns and everybody else had fish. So there was a lot more, as well as fish, wild rice, deer, the whole thing."

Do you remember a time when people harvested rice in Bad River Slough or Honest John Lake?

Bob Powless: "Oh yah. When I was a kid they used to do that. In fact, I'm pretty sure that the Mayotte family, old John Mayotte and his sons, I'm pretty sure that they used to go down there . . . and Edonce, I can't remember his English name, Edonce used to go down there and rice too. He and old John Mayotte and his family, and probably some Gordons that lived by the river over there, probably went down there too. They collected driftwood for firewood. That's how they used that river too, one of the things they did.

"Fishing. Netting in the spring. We've always done that. They used to build a weir over here and then fish through an opening, spear them through the opening. Right over here, in Bad River. About 6 foot deep, or used to be about that."

Eugene Bigboy: "I can remember way back when there was more rice on Bad River and the sloughs and the Honest John area. Why it sort of diminished I really don't know. But Bad River is altogether a lot different than the Kakagon Slough area. You know, every spring they have some pretty high water, rough water, high water, powerful waters that go through there. So I suppose that takes a toll on it."

Sam Livingston: "Yes. I did it myself. In my earlier years there was a stand of wild rice up and down the river, but it wasn't as plentiful as the Kakagon."

Does anyone harvest it today?

Sam Livingston: "No. The rivers have widened, for a variety of reasons. I'm not sure in what sequence or what order it happened but the rice . . . is choked up now (?)."

Denomie Creek

Do you ever remember anyone catching fish or swimming in Denomie Creek?

Bob Powless: "I don't remember it, but being the way that people lived at that time it's possible. It's possible that they swam in there and they probably caught fish in there. Probably. They probably caught trout in there."

Sam Livingston: "I would suppose that one time and I'm not so certain about this, I suppose at one time because the lower part [of Denomie] goes into the river [the Bad] that the fish would swim up. My guess is it would be mostly pickerel, maybe some sturgeon, and some smaller fish like blue gills and bass, but they wouldn't go up too far."

Eugene Bigboy: "Denomie Creek? Sure. In fact there's a big water hole right next to the old tractor right by here, maybe a hundred feet off the highway. It's right over here. A big old pond there. In fact, we used to jump in there every once in a while. And as far as fish, yah, there's fish in there. We used to catch a lot of perch. The water gets high sometimes, in the springtime. A lot of fish come up in there."

Do the fish in Denomie come up from Bad River, swimming upstream?

Eugene Bigboy: "Yeah, from the slough area, Bad River Slough area. I don't know if I'd eat those fish now. I understand that part of our lagoon is emptying into Denomie Creek."

Does anybody use Denomie Creek for anything today?

Bob Powless: "Not that I know of. Well, trapping. Trapping. There's a lot of beaver dams on it. And that would go all the way up to Birch, the beaver dams."

Changes to Natural Resources over Time

In your lifetime, how have you seen the natural resources change on the reservation?

Eugene Bigboy: "Well, what I've seen is probably changes due to all the modern technology that you have today. In my earlier days, I never ran into people or different kind of wildlife agencies wanting to put chemicals in the rivers and stuff like that. Nothing in those days. Of course, all those things that are damaging our lakes now come in through the St. Lawrence Seaway and stuff, hanging on the bottom of these boats. So I suppose back in those days there wasn't really that much coming through. I guess modern technology has to go right along with it, to see if they can get rid of them. I don't know if it's good or bad. I suppose it's good."

Sam Livingston: "Well, it's changed. The abundance of waterfowl and the variety of ducks have declined to such a degree that you really have to go search them out. They are not like they were when I was growing up. You didn't have to search. You just got in your boat and paddle up the river or motor up the river and they'd be there. But today you have to go and search them out because there are so few, because their numbers have diminished so much.

"And this didn't only affect the duck. The fish, too. All the big ol' walleye and big ol' northern pike. It was nothing to get a big northern. And you could see them in that water. The water was clear. They would be laying there, almost motionless. But today you know it's water but you can't see down in it. And the fish aren't there."

Were all the waterways clear back then?

Sam Livingston: "All the waterways were clear then. They were narrow. The rice went straight out to where you had a channel, it looked like a channel. That's what I really thought it was. . . . And the beaver, well, there wasn't too much beaver in the Kakagon, but there was some. And there was muskrat, and there was a whole lot of otter, mink, fishers, martens, and the like that my grandmother and my uncle used to tell me about, and show me. There were bear all over the place. They would come out and splash through the rice beds. It was nothing to run into bear as you were gathering firewood.

"The rivers are an important part of our life. It was nothing for us to swim across this river. Every summer it was nothing for the kids to be swimming in the river. But now they don't do it anymore. They prefer going into town to the pool. They prefer swimming in a pool over the rivers or Lake Superior. There's a variety of reasons for that. Too many flies. There's an imbalance in the ecosystem, I think, because we never had those flies. A contributing factor to that (kids don't swim here) might be the red clay. The water here has always been muddy with red clay. But there were times when it too was clearer. When we swam in it we never had to worry about contamination. It wasn't told to us by our parents or our grandparents that the water was contaminated.

"Adjacent to the reservation the farms and the purchases of land for people to live—they begin up above the reservation. The Bad River starts way above the reservation, the White River, and all these other rivers. All the rain and runoff because of pesticides and whatever else they use for their farms would run off. . . . We were situated right in the middle of all this stuff. We're between Lake Superior and we're in between Ashland County. . . .

"And in the White River right there, we used to paddle up that river. And it also was clear. . . .

"Just about every family had maple sugar camps where they used to go. . . . We didn't have the system we have today. . . . Everybody depended on everybody else. Everybody had to pull their share. Everybody willingly did it because the outcome was the same as making wild rice. You had enough maple sugar and maple cakes, syrup to last you two years. The rest you gave away. They never thought about selling it, they never did it commercially. They did it because it was something that would sustain them through the hard times, the winter times. It was a learning experience. . . . It was kind of a system. It was organized. It was everything."

Have you seen a change in fish and bird populations in your lifetime?

Bob Powless: "Oh yah. Yah. Fish populations. It was down when I was a kid. Then it came back up. Now I think it's on a decline again. There's a lot of pressure out there on the lake. And I think it's on a decline again or it's slow coming back."

Eugene Bigboy: "Yah, I've seen a decline in the birds, and a decline in the ducks. There was some periods of time here where, I don't know what caused it, but there was dead birds laying all over. I don't know if our tribe had to address that problem, but there used to be birds just laying around dying for some reason, probably within the last I'd say 20 years."

Concerns about the Natural Resources

Do you have concerns about any of the natural resources on the reservation?

Eugene Bigboy: "I think we have to struggle to hang onto what we do have left here. I think they're dwindling away, but I guess we have to believe in progress at home and with the rest of the world. You know I'm not a traditionalist where I go back and say I'd like to live like the old Indian. I don't know if I could do that, or survive doing that."

Cecilia Mix: "Oh yes, lots of them. The count of the ducks, for one thing. I wrote to . . . Susan and I, Susan Wolf, we wrote to. . . . I still get letters from him, I think I have a letter there someplace, our Senator. About them running those motor boats through the rice fields you know, and through the duck habitat, muskrat. I still get letters from him, our Senator."

How do you think things should change to make it better?

Cecilia Mix: "Keep the motor boats off of especially Kakagon. Because that's really the duck habitat, you know. And the duck and the muskrat. And the loons, we don't have any loons anymore I don't think. We went down to the lake there one time. Someone must have shot a little loon and just left it lying."

Areas for Water-Quality Testing

Do you think there are certain areas of the reservation where water-quality testing should be done?

Eugene Bigboy: "Well, I don't know. I think basically all our inland waters are fine, well, I shouldn't say that, we're having problems with water now. I'd like to keep Lake Superior waters as clean as possible. We don't have a lot of outlets here from the reservation, but we have a lot of outlets dropping a lot of stuff in Lake Superior from the city of Ashland, which is a few miles down the road. I've been down to the lake this year already, me and my oldest boy and there's a lot of stuff in the water along the lake shore. It was never there before. Of course, I went to school in Chicago and I went down by the lake there [he laughs]. This was years ago too so I think we may be pretty well off yet."

Bob Powless: "Certain areas? I think the whole area, the whole reservation, should be tested. I read that report from the people that did the water-quality study around here a couple months ago. And it surprised me that they found there was contamination way up there where I didn't think there was going to be—up at Manypenny's. They have a lot of lead in there. But there was a comment in that paper that there are some types of pumps, electric pumps, that contaminate water with lead so that could be something to check into."

Management of Natural Resources

Do you have any concerns about how tribal members treat the natural resources?

Bob Powless: "Yah, I'm concerned about overuse. I'd like to follow some guidelines. We need to regulate. There's no getting around that. Every year there's more pressure on fishing from outside. A lot of tourists come up from Bayfield. For instance, our walleyes. They have a small hatchery here, and they've been tagging those fish for several years. And they've found tagged fish from here over by Superior, about 70 miles from here. So they do spread out from here, those walleyes. Very seldom do we get large lake trout anymore. Used to be hundred pounders, lot of them hundred pounders. Now ten or twelve pounds, that's big."

Cecilia Mix: "Yes. There's a guy that wanted to clearcut my brother Charlie's land, it's on Long Island. I told him don't, don't dare touch one stick. We need all the resources we can get around here. I said if there's dead logs lying in the woods, just leave it. They provide shelter for little animals."

Do you think that the environment is being treated differently by people now than it was 20 years ago?

Eugene Bigboy: "I can only answer for myself. I basically think that the Indian people are treating it just as well [as 20 years ago], but we do have areas down in the sloughs where non-Indians have purchased the land or leased the land for some reason. They have sewage going right into the rice beds and stuff like that. We've been fighting that problem for a while. I don't think that's right. I don't think that's treating the environment right."

Do you feel the tribe has managed the resources well?

Eugene Bigboy: "Well, I guess I have to speak for myself. I am a former chairman. I was chairman for nine years. I was also a member of the board for an additional nine. So I've got 18 years of tribal council experience under my belt. And from what I've seen today, councils get a lot of pressure put on them by their members. Just recently I saw this agency wanted to put some chemicals in the water for lamprey. And that caused a big problem with a lot of people on the reservation. They didn't want it to happen. Even though the people pointed out the major problem that it was going to pose later on, they still put it off for a year. I didn't think that was right. I think if you run into a problem you have to deal with it right away."

Sam Livingston: "Back when I was talking to you about organizing then I believe the Indian people had good management of the forests and the wildlife resources. They had good management then, because they didn't do anything with it. They didn't harvest all the trees or commercialize deer meat. . . .

"Things were a lot simpler then because the emphasis wasn't on getting rich like it is today. You can't get anything today unless you have money. . . .

"The forest management, I'm really critical of the way things are right now. With the influence of the Bureau of Indian Affairs, and that interpretation of that influence . . . I do believe they don't realize what they've done. And the Bureau is partly to blame for that, but the tribe is more important. They didn't try to stop the pollution. They didn't try to stop the contamination of all that sludge all over this reservation.

"You see, we always thought, and I think the prevailing attitude here was that we would always have this, that it would always be here. We're not touched by the outside world. We're not touched by people adjacent. But we are. And we were. And we still are. The deer, the bear and the animals all drink the same water we drink, at different points.

"The fish. Bad River has fish, but part of the reason people don't want to eat it now is the high content of mercury. So that's a deterrent right there. Why should I eat the fish if I can go buy it?. . . .

"When you cut all the timber and there's no reforestation too, in the plan of cutting, then what you have is soil erosion, you have runoff. When the rain comes down there's nothing to soak up the rain. It just runs off into the river.

"One of the things you should do is get in an airplane and fly over this reservation and follow what I'm talking about. Everybody thinks it's just that river there and the lake. But there's *a lot* of water on this reservation, there's a lot of swampy areas, there's a lot of sloughs, and a lot of everything on this reservation. And this is a particularly touchy region for everybody, not only for the Indian people. You know we're right between two watersheds.

"And I've had the good fortune to have flown over this thing maybe 20 years ago. I've seen it in the wintertime, I've seen it in the summertime, I've seen it in the springtime, I've seen it when all the leaves are out, up in the air, and I've followed all those things, and I knew what resources we had then.

"I was involved in tribal government for a while. I was a tribal chairman here about three terms. When I look back at that particular segment of my life, it was a wasted effort. It was a learning experience, though. I gathered a lot of information, but I didn't know how to use it, I didn't know how to use it. And all the people along side me didn't know how to use it either. So what I was doing was groping blindly in this effort to preserve what we had. And I didn't know how to use the word. I could see all those resources that we had, I could see all those things that we might have had, but I didn't know how to use the words to get them to see it.

"And I used to tell them, why don't you go and hire a plane and fly over and *know* what you got and see what you have. You have timber, you have water, you have grasses, you have all kinds of things. And it's *worth protecting*. This is where we live. This is where our kids are going to be. This is where our families are going to be, hopefully, for the rest of our lives, your life and mine.

"I think we're mismanaged to a large degree. And I don't think the blame lies solely with the Bureau of Indian Affairs. I think the tribe has to accept the responsibility and be accountable for that. Otherwise, we continue groping in the dark. . . .

"When I first saw it this place was full and loaded. And now you can see for miles without seeing a tree. What does that do? That's our natural resource, not only natural for us but natural for everybody.

"Now planning, we don't have any planning, just crisis management. . . . We don't have any laws that say we can have the federal government and the state government and the county government support us in our efforts. . . . Now if we had laws on dumping waste, pollutants and the like, we may not have stopped them [American Can] but at least we would have had some sort of a plan. And then we could get the state and the federal governments to enforce those laws, to help us enforce those laws. If a court case comes up, at least we then have a law in a place. . . . But we also keep talking and never put those things together. That's why actually we mismanage the resource.

"And during all this chaotic crisis management, the family deteriorates. No one plans wild rice outings, or maple sugar outings, no one plants big gardens anymore. I can go over to the mall and get anything I need, go to the supermarket and get anything I need. I can go to the fish market and get anything I need.

"This is here for our families, forever and ever. I want to pass this on. . . . I know what I used to have and it's not here now. . . .

"The Creator did all this for us and we're just stewards."

Law and Native American Tribes

Introduction

Environmental statutes, regulations, and judicial decisions affect how a reservation's water resources are managed. Since the 1970s, comprehensive federal statutes have dominated environmental law in the United States. Increasingly, however, federal court decisions influence resource management as tribes, states, and local governments vie to control reservation lands and waters. Understanding the legal principles that govern environmental regulation on Indian lands can help the Bad River Band preserve its lands, waters, and resources for generations.

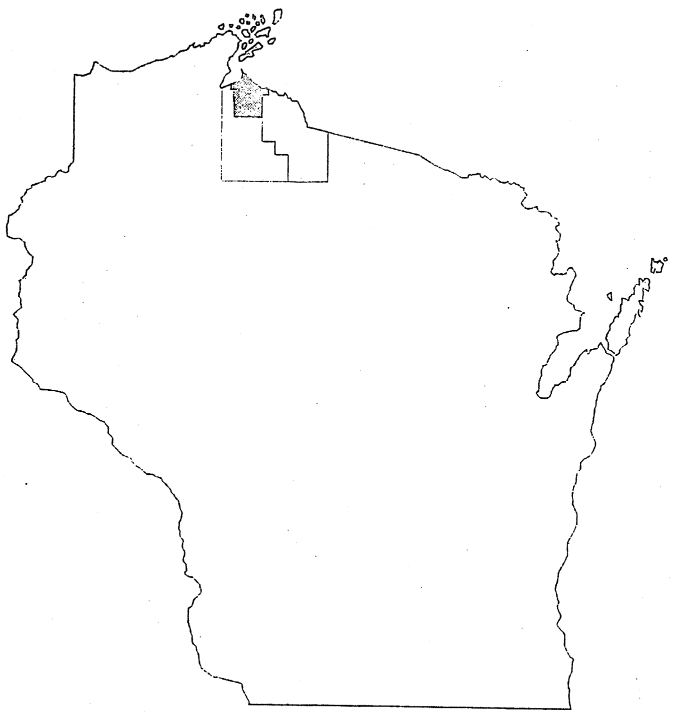
We begin this section by discussing tribal sovereignty and the federal trust responsibility—concepts that reveal the unique status of Indian tribes in Ameri-

ATTACHMENT J

Water Resources of the Bad River Reservation, Northern Wisconsin. Water Resources Investigation Report 95-4207. Batten and Lidwin.

Appendices omitted

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 95-4207



Water Resources of the Bad River Indian Reservation, Northern Wisconsin

Prepared in cooperation with the
BAD RIVER CHIPPEWA
INDIAN TRIBE
OF WISCONSIN

WATER RESOURCES OF THE BAD RIVER INDIAN RESERVATION, NORTHERN WISCONSIN

By W.G. Batten and R.A. Lidwin

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 95-4207

Prepared in cooperation with the
BAD RIVER CHIPPEWA INDIAN TRIBE OF WISCONSIN

Madison, Wisconsin
1995

CONTENTS

PLATES

[Plates are in pocket]

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	.004047	square kilometer
square mile (mi^2)	2.590	square kilometer
inch per year	25.40	millimeter per year
foot per day (ft/d)	.3048	meter per day
foot per mile (ft/mi)	0.1894	meter per kilometer
gallon per minute (gal/min)	0.06309	liter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Temperature, in degrees Fahrenheit (°F) can be converted to degree Celsius (°C) by use of the following equation:

$$°F = 1.8 \times °C + 32.$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in this report: Chemical concentrations and water temperature are given in metric units. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Specific conductance of water is expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm). This unit is equivalent to micromhos per centimeter at 25 degrees Celsius (µmho/cm), formerly used by the U.S. Geological Survey.

Water Resources of the Bad River Indian Reservation, Northern Wisconsin

By W.G. Batten *and* R.A. Lidwin

Abstract

Water-resources data were collected in the Bad River Indian Reservation of northern Wisconsin from 1983 through 1987. Some data are interpreted to describe ground-water flow, ground-water quality, streamflow, and surface-water quality. Data also are presented in tables and appendixes for baseline reference.

Precambrian sandstone and basalt underlie varying thicknesses of sandy till, outwash sand and gravel, and clay deposited in glacial meltwater lakes. The thickness of glacial deposits generally ranges from 100 to 300 ft but reaches a known thickness of almost 1,000 ft on the east-central edge of the Reservation. Sand and gravel deposits are generally buried beneath 50 to 150 ft of glacial lake clays and silts throughout most of the Reservation. These buried sand and gravel deposits lie directly on Precambrian sandstone of unknown thickness in the northern half of the Reservation. The sand and gravel deposits and the sandstone form a single aquifer system confined by the overlying clay deposits. In and near the village of Odanah, numerous wells finished in either the sand and gravel or in the sandstone flow above land surface.

Estimates of the horizontal hydraulic conductivity of the sand and gravel based on 30 specific-capacity tests range from about 2 to 700 ft per day with a median value of about 80 ft per day. Horizontal hydraulic conductivity estimates for the sandstone range from about 1 to 360 ft per day with a median of about 2 ft per day. These estimates are based on 42 specific-capacity tests of wells open only to the upper 20 to 60 ft of sandstone. The horizontal hydraulic conductivity of the sandstone appears to decrease with depth; highest estimates were determined for wells open only to the upper 20 ft of sandstone.

Ground water in the confined aquifer system is a calcium magnesium bicarbonate type with relatively low total dissolved solids concentrations. The median total dissolved solids concentration of water from 17 sand and gravel wells is about 150 milligrams per liter and the median for water from 21 sandstone wells is about 244 milligrams per liter. High concentrations of iron and manganese were found in water from 12 of 36 sampled wells. Total recoverable concentrations of iron exceeded 500 micrograms per liter in 5 wells and concentrations of manganese exceeded 50 micrograms per liter in 7 wells.

Streamflow has been continuously measured at a streamflow-gaging station in the Bad River near Odanah for much of the time since 1914. This station monitors drainage from a basin with an area of 597 square miles and the average daily discharge of the Bad River at this gaging station is 622 cubic feet per second. The peak instantaneous flow at the station was 27,700 cubic feet per second on April 24, 1960 and the minimum instantaneous flow was 34 cubic feet per second on November 8, 1976.

Analysis of water samples collected at 12 sites at 10 small streams during base-flow conditions indicate that the concentrations of common chemical constituents are similar to but lower than those found in ground water. The median concentration of total dissolved solids was about 110 milligrams per liter as compared to about 155 milligrams per liter in ground-water samples from wells finished in sand and gravel.

INTRODUCTION

Hydrologic and water-quality data were collected on the Bad River Indian Reservation from 1983 through 1987 by the U.S. Geological Survey (USGS), in cooperation with the Bad River Chippewa Indian Tribe of Wisconsin. These baseline hydrologic and water-quality data will be used by tribal planners and leaders to manage and protect the water resources of the Reservation.

Purpose and Scope

This report summarizes ground- and surface-water data collected during the study. Ground-water and streamflow data have been analyzed and interpreted; surface-water quality data are presented in tabular form with minimal interpretation and discussion. Data from seismic-refraction survey lines and drillers' well-construction reports were used to compile maps of the altitude of the bedrock surface, the thickness of glacial deposits, and the potentiometric surface of the confined ground-water-flow system. These data also were used to construct an idealized geologic section and a conceptual model of the ground-water-flow system. Selected well-construction data were analyzed to estimate the hydraulic properties of the sand and gravel and sandstone aquifers that make up the confined ground-water-flow system. Water samples from wells, streams, lakes, and sloughs were analyzed for major ions and trace metals. Streamflow data were analyzed to determine flow-duration, flood, and low-flow frequency characteristics of the Bad River near Odanah.

Identification of Data-Collection Sites

Each surface-water data-collection site and well mentioned in this report and shown on plate 1 has a unique identification number. The system for assigning these identification numbers is based on the geographic location of the surface-water sites and wells. There are two groups of surface-water data-collection sites: streamflow-gaging stations and sites used for collecting surface-water (and bottom material) quality samples. Each streamflow-gaging station has a "downstream order number" that consists of seven or eight digits, with the number increasing in the "downstream" direction within a given stream basin. Each surface-water quality sampling site has a unique fifteen-digit identification number that combines the (approximate) latitude and longitude of the site plus a two-digit sequence number which further distinguishes each site.

Wells and springs also are identified by a unique 15-digit number that is a combination of the site's latitude and longitude and a two-digit sequence number. The sequence number distinguishes sites located less than about 100 ft from each other with the same latitude and longitude. Each well is also identified by a local number in addition to the identification number. The local number consists of an abbreviation for the county name; the township, range and section; and a four-digit sequence number assigned to the well. For example, well AS-46/03W/20-0221 is located in Ashland County (AS), township 46 north, range 3 west, section 20; its sequence number is 0221. The local number is used in the appendixes in this report. Only the last two or three digits of the four-digit sequence number are used to identify wells and springs on plate 1.

Description of Study Area

The Bad River Indian Reservation encompasses about 195 mi^2 in northeastern Ashland County in north-central Wisconsin (fig. 1). The Reservation also includes a 9-mi^2 area in northwestern Iron County and a small, 196-acre parcel of land on the northeastern tip of Madeline Island (fig. 1) in Lake Superior. The parcel on Madeline Island is not included in the present study.

Lowlands in the northern two-thirds of the Reservation contain many wetlands. This part of the Reservation slopes at a rate of about 10 to 15 ft/mi to Lake Superior, which has a mean elevation of 602 ft above sea level. A 20-mi^2 area of marshes and sloughs borders Lake Superior at the mouths of the Bad and Kakagon Rivers (pl. 1). Uplands in the southeastern part of the Reservation rise over 500 ft above the lowlands to more than 1,250 ft above sea level.

Approximately 85 percent of the Reservation is covered by second-growth forest of aspen and white birch. Northern hardwoods and white pine cover the few upland areas. Swamp and marsh vegetation cover the wetlands along Lake Superior (U.S. Department of Housing and Urban Development, 1976). Virtually no agricultural crops are grown on the poorly drained clay soils that cover most of the land.

GEOLOGIC SETTING[1]

Precambrian basalt and sandstone bedrock underlies the entire Reservation. A sequence of dark-colored volcanic basalt lava flows, sometimes referred to as "traprock," underlies the topographic high in the extreme southeastern corner of the Reservation (fig. 2). The Oronto Group, a sequence of sandstone with some shale and conglomerate (Mudrey and others, 1982), underlies most of the Reservation (fig. 2). The youngest of the bedrock units is called the Bayfield Group. This unit consists of nearly flat-lying sandstone and is found in the northwestern part of the Reservation (fig. 2). The contact between the Bayfield and Oronto Groups is somewhat uncertain. The basalt lava flows are about 1 to 1.5 billion years old and the youngest

[1]The stratigraphic nomenclature used in this report is that of the Wisconsin Geological and Natural History Survey and does not necessarily follow usage of the U.S. Geological Survey.

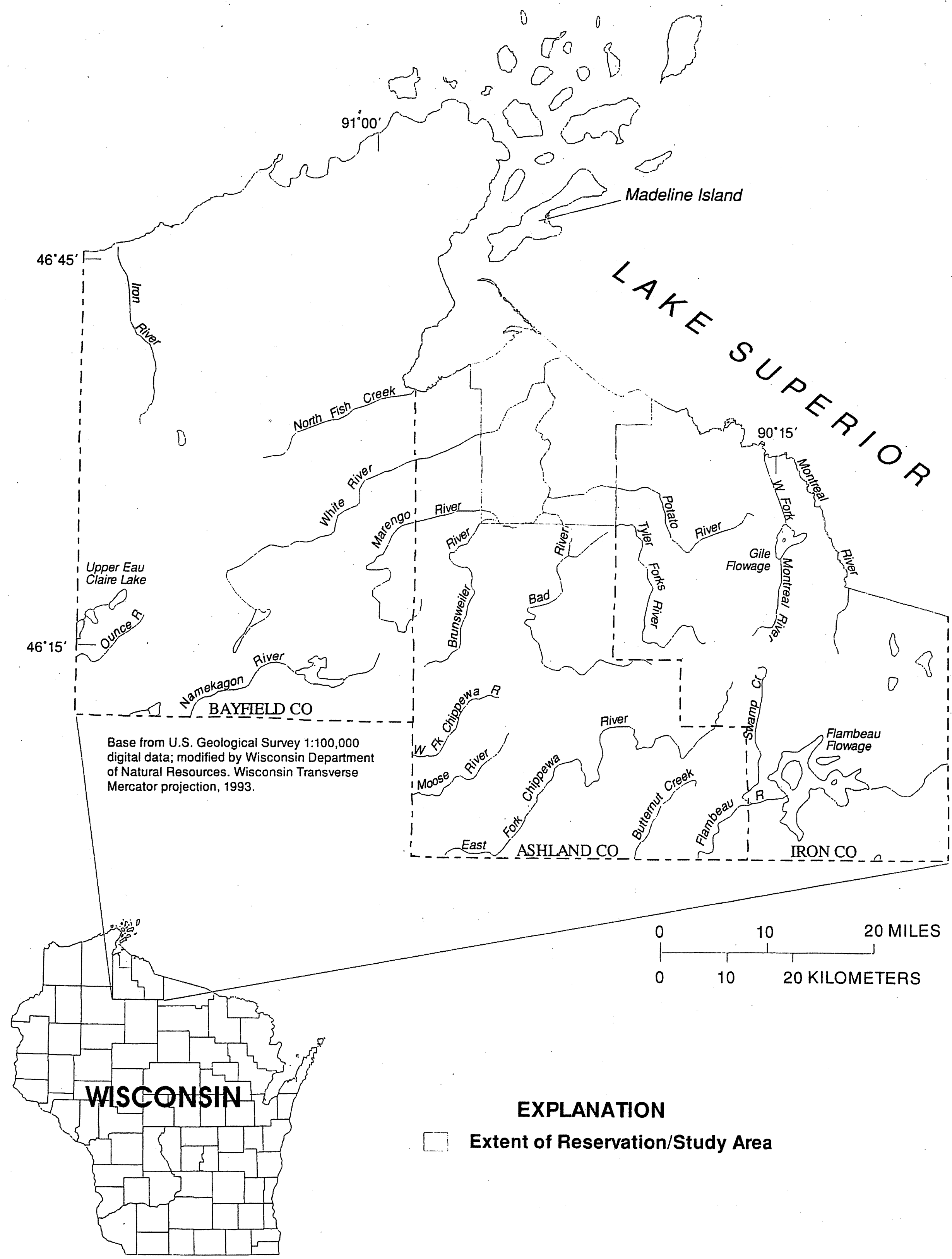
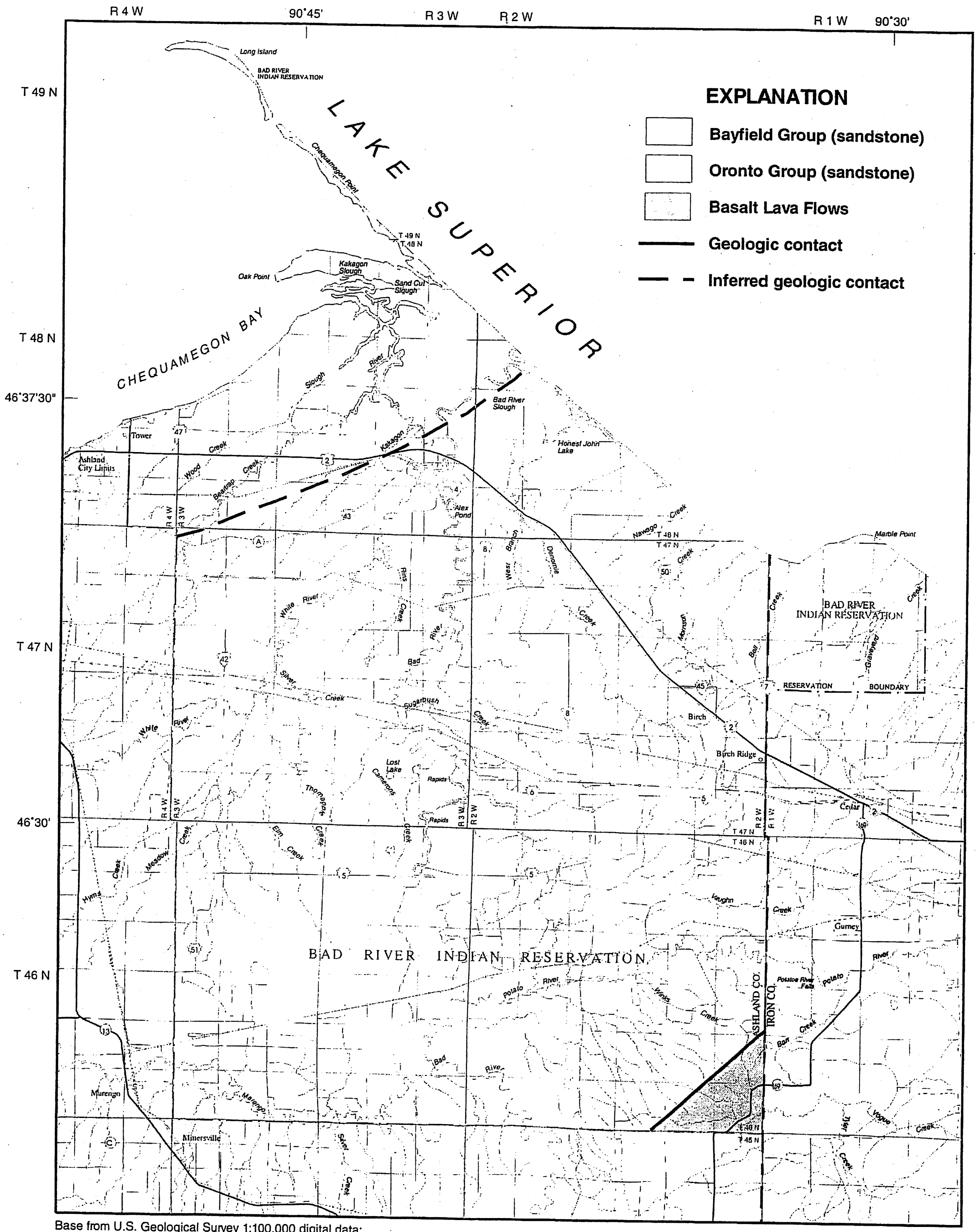


Figure 1. Location of the Bad River Indian Reservation in northern Wisconsin.



Base from U.S. Geological Survey 1:100,000 digital data; modified by Wisconsin Department of Natural Resources. Wisconsin Transverse Mercator projection, 1993.

0 1 2 3 4 MILES

0 1 2 3 4 KILOMETERS

Figure 2. Bedrock geology of the Bad River Indian Reservation.

rocks in the Bayfield Group are just under 1 billion years old (Mudrey and others, 1982).

Drillers' geologic logs, outcrop locations, and seismic-refraction data were analyzed to determine the altitude of the bedrock surface in feet above sea level. Plate 2 is a contour map of the bedrock surface from a plot of these data. The shape and location of contour lines are inferred in large areas of the Reservation interior where few data are available. The bedrock surface ranges from a known altitude of about 1,150 ft above sea level in the extreme southeastern corner of the Reservation (pl. 2) to about 20 ft below sea level determined from a seismic-refraction survey line just east of the Reservation boundary in section 31 of T47N, R1W, about 1 mi southeast of the settlement at Birch Ridge (pl. 2). Two community-supply wells at Birch Ridge also penetrate more than 950 ft of glacial material that overlies sandstone bedrock. This bedrock low extends from the Birch Ridge area to the southwest as a bedrock valley, or more likely as a structural trough formed by folding of the bedrock layers (M.G. Mudrey, Wisconsin Geological and Natural History Survey, oral commun., 1989). Another broad but shallower bedrock trough appears to underlie the central part of the Reservation and trends from the southwest to the northeast with bedrock altitudes ranging from 300 to 400 ft above sea level (pl. 2).

Wisconsin stage glacial deposits directly overlie Precambrian bedrock throughout most of the Reservation. The glacial deposits in the Lake Superior region of northern Wisconsin that includes the Bad River Indian Reservation have been described by Clayton (1984). Clayton (1984) identifies glacial deposits within the Reservation as part of the Miller Creek Formation (fig. 3) deposited approximately 9,500 to 11,500 years ago, or as part of the Copper Falls Formation, deposited earlier than 11,500 years ago. Deposits of the Miller Creek Formation overlie the Copper Falls Formation throughout most of the Reservation (fig. 3).

The Miller Creek Formation consists of two types of deposits: (1) clayey till that was reworked by glacial-meltwater lake-wave action, and (2) offshore clay and silt deposited by turbidity currents flowing into glacial lakes (Clayton, 1984). The offshore clay and silt which covers most of the lowland along Lake Superior is locally referred to as the "red clay." This material underlies Quaternary alluvial sand and gravel deposited along major streams and underlies recent organic deposits in wetland areas.

The Copper Falls Formation consists of sandy till and sandy outwash deposited by glacial meltwater. These deposits underlie the Miller Creek Formation throughout most of the Reservation (fig. 3). The Miller Creek Formation is absent in the extreme southeastern corner of the Reservation where the Copper Falls Formation extends from land surface to volcanic bedrock (fig. 3). Glacial deposits older than the Copper Falls Formation may be present where the thickness of glacial deposits exceeds 300 ft or more.

Glacial deposits overlie sandstone bedrock in the northern half of the Reservation (fig. 4). The thickness of glacial deposits differs greatly throughout the Reservation. Average thickness ranges from 200 to 400 ft but attain a maximum thickness of the glacial deposit is about 1,000 ft in the center of the bedrock trough along the east edge of the Reservation (fig. 4). Glacial deposits are less than 100 ft thick in the upland area in the southeastern and west-central part of the Reservation. Sandstone bedrock crops out along the Bad River in sections 35 and 36 of T47N, R3W (pl. 2). The thickness of glacial deposits is estimated in many areas of the Reservation where no data are available.

GROUND WATER

All water used by Reservation residents is supplied by wells that pump water from saturated sand and gravel deposits or Precambrian sandstone. The occurrence and availability of this ground water is determined by the hydraulic properties of these deposits.

Occurrence and Flow

Ground-water occurrence and flow can best be described by referring to the geohydrologic section shown in figure 3. The shaded zones represent the two ground-water-flow systems. The shallow system represents flow that takes place at shallow depths (probably less than 50 ft in most areas). Flow paths, indicated by small arrows, within this shallow system tend to be short. Flow begins as precipitation infiltrates the soil and moves downward through vertical cracks (fractures) in the generally clayey Miller Creek Formation. Flow is horizontal through thin sand or silty layers interlayered in the clay in this shallow system. Some water flows in the clay itself at the microscopic level. However, the velocity or flow rate of water in the clay is probably on the order of 1 in/yr or less. Ground water in this shallow system generally flows from topographic highs toward the nearest stream or wetland where the water seeps (discharges) into the surface-water body. The level below land surface in this shallow system where all openings between individual sand grains or clay particles are completely saturated is called the water table (fig. 3); the shallow system can be referred to as a water-table system.

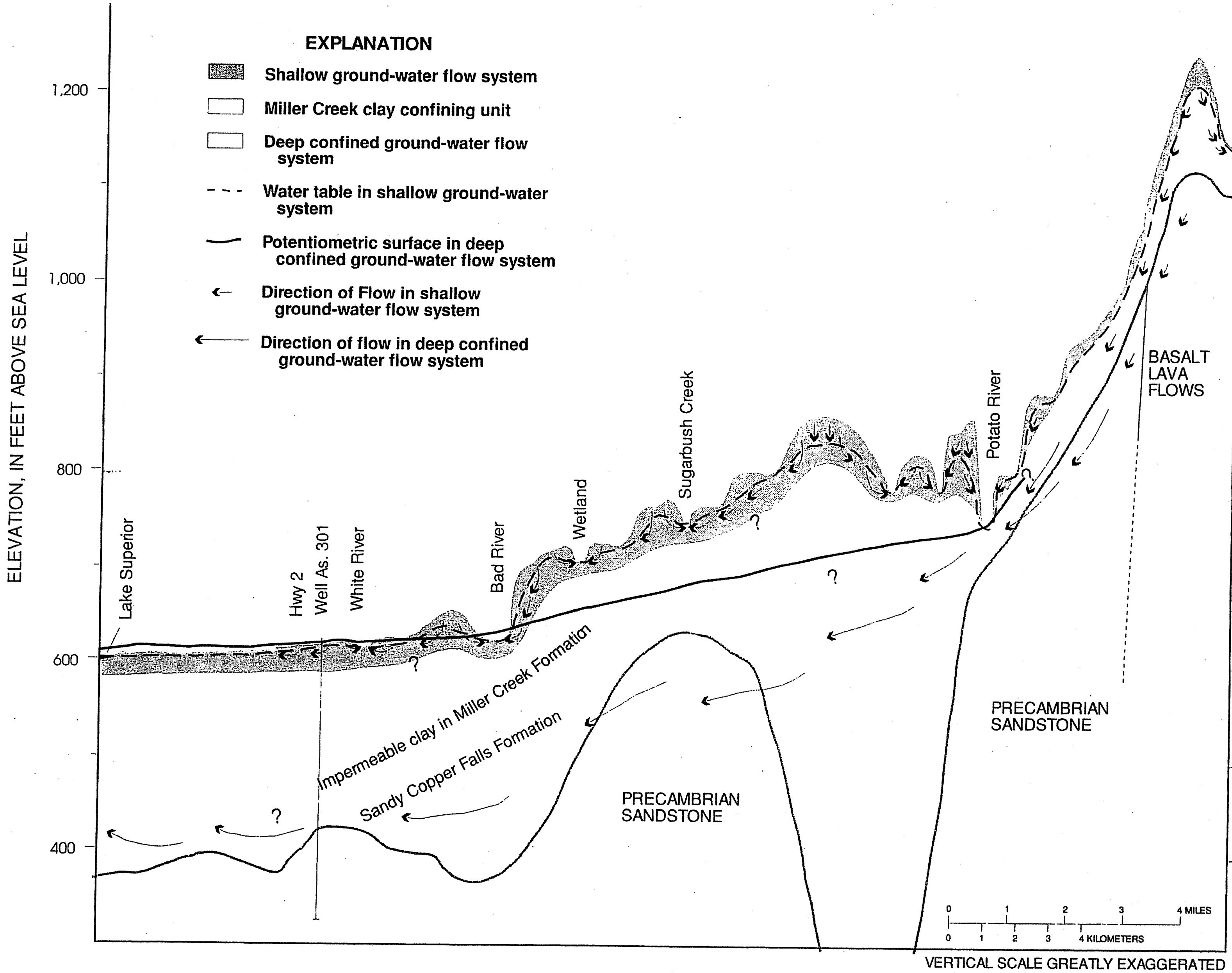
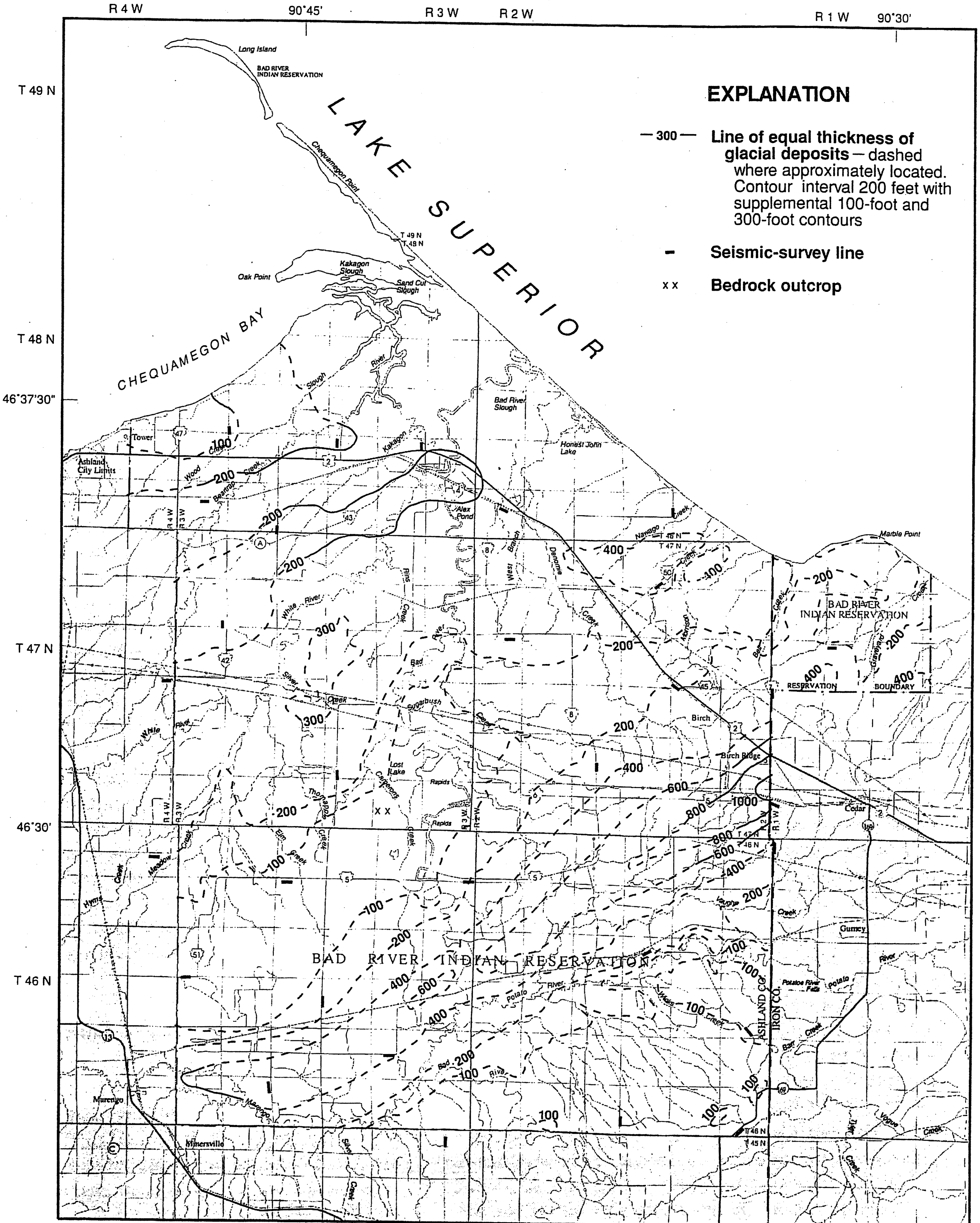


Figure 3. Idealized geologic section and conceptualized ground-water-flow systems within the Bad River Indian Reservation.



Base from U.S. Geological Survey 1:100,000 digital data; modified by Wisconsin Department of Natural Resources. Wisconsin Transverse Mercator projection, 1993.

0 1 2 3 4 MILES

0 1 2 3 4 KILOMETERS

Figure 4. Thickness of glacial deposits within the Bad River Indian Reservation, northern Wisconsin.

The shallow system is separated from the deep system by a layer of massive clay in the Miller Creek Formation that probably ranges from about 50 to 150 ft in thickness (fig. 3). The clay at this depth does not contain channels created by plant roots or by the chemical or physical breakdown of clay material by infiltrating precipitation. Therefore, this clay is not able to conduct water unlike the near-surface clay deposits that comprise the shallow (water-table) system. As a result, the channel-free clay acts as a layer that retards the vertical flow of water and confines the deep ground-water-flow system.

The deep ground-water-flow system is referred to as a confined or artesian aquifer system. In this deep system (fig. 3), ground water flows through both the permeable Precambrian sandstone and sand deposits of the Copper Falls Formation. The deep system is a large regional flow system, as indicated by the long arrows in figure 3. Water in this system comes from precipitation and snowmelt infiltrating the sandy Copper Falls Formations (fig. 3) in the upland area in the southeastern part of the Reservation and in uplands south of the Reservation (not shown). Ground water generally flows northward within these deposits toward Lake Superior (fig. 3) and becomes confined where the thickness of the overlying clay layer of the Miller Creek Formation is great enough to retard vertical movement. In upland areas, the deep system is not confined by overlying clay, and flow of the ground water is similar to that in the shallow system, where the ground water flows along short paths from topographically high areas toward nearby headwaters of streams. However, some of the ground water in these upland areas does not discharge to streams; instead, it flows along extended flow paths under the confining clay layer, as shown by the long arrows in figure 3.

As water moves northward under the clay, the hydraulic head or pressure on water in the deep flow system can cause the water level in a well open only to this flow system to rise above the top of the system. The imaginary surface representing the water levels in these wells is commonly called the potentiometric surface of the ground-water-flow system. The altitude of the potentiometric surface is shown in figure 5.

The relation between the water-table and the potentiometric surface is important for understanding the overall flow system. This relation depends on the hydraulic gradient. The hydraulic gradient is simply the difference or change in the hydraulic (pressure) head over the distance from one point in the ground-water system to another point in the system. Where the water table is above the potentiometric surface, some water flows downward from the shallow system through any confining clay and into the deep system, because ground water flows from areas of high hydraulic (pressure) head toward areas of low hydraulic head.

In the lowland area near Lake Superior, the hydraulic gradient is reversed. The hydraulic head in the confined (deep) system is greater than in the shallow water table system. This is evidenced by water levels in a number of domestic wells open to sandstone or sand and gravel in the deep system near the village of Odanah. Water levels in these wells are above the land surface, which causes the well to flow.

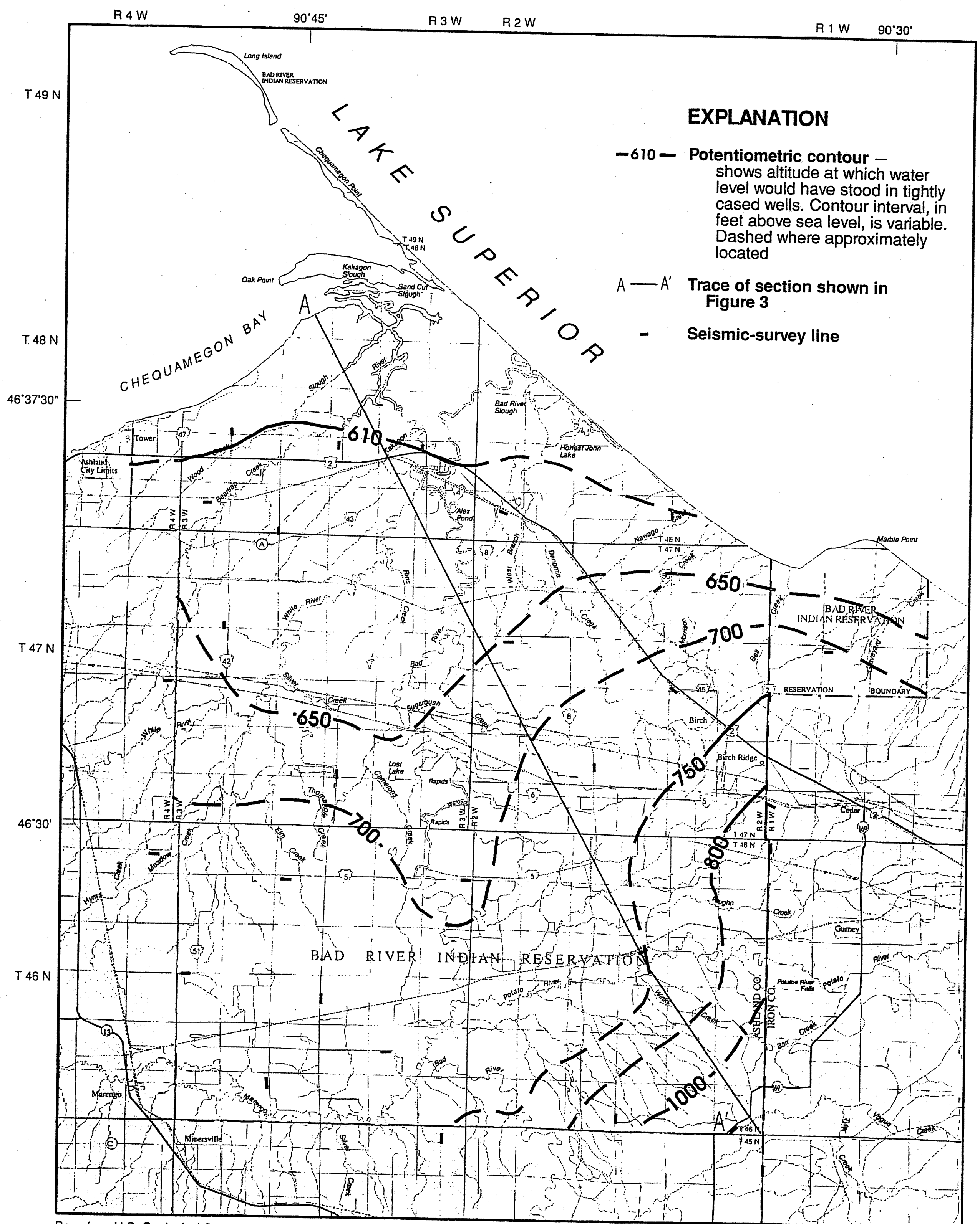
Availability

In 1988, information was available for 90 wells within the Reservation boundaries. Eight of these wells were community-supply wells serving a total of 205 homes in New Odanah, Odanah, and the community on Birch Ridge. The remaining 82 domestic-supply wells served individual homes throughout the Reservation. Drillers' construction information is available for 72 of the 90 wells. Forty-two of the 72 wells are finished with the borehole open to and receiving water from Precambrian sandstone. The remaining 30 wells typically are finished with 2-, 3-, or 4-ft-long screens open to sand and gravel deposits of the Copper Falls Formation just above the sandstone bedrock. General construction information for each well is listed in appendix 1. Well locations are shown on plate 1.

Wells finished either in the sand and gravel deposits, or in sandstone, appear capable of producing yields for domestic purposes in those few areas of the Reservation where well data are available. Drillers report well yields of about 5 to 20 gal/min for domestic supply, and about 25 to 90 gal/min for community-supply wells. Yields larger than those reported are possible depending on lithology and location.

Aquifer Characteristics of Sand and Gravel Deposits

Sand and gravel deposits, which are probably part of the Copper Falls Formation (fig. 3), generally are found between the depths of about 175 and 225 ft below land surface in the populated areas of Odanah and New Odanah, and at varying depths in the upland area around the community of Birch Ridge (pl. 1). Specific-capacity data from drillers' construction reports exist for 30 wells that obtain water from sand and gravel deposits in these areas. The specific capacity of a well is the rate of water pumped, in gallons per minute, divided by the total drawdown that occurs from



Base from U.S. Geological Survey 1:100,000 digital data; modified by Wisconsin Department of Natural Resources. Wisconsin Transverse Mercator projection, 1993.

0 1 2 3 4 MILES

0 1 2 3 4 KILOMETERS

Figure 5. Potentiometric surface in the deep confined ground-water system within the Bad River Indian Reservation, northern Wisconsin.

pumping. Drawdown is the decline, in feet, of the water level in the well caused by the pumping.

Drillers' specific-capacity data were analyzed using a procedure developed by Bradbury and Rothschild (1985) to estimate the horizontal hydraulic conductivity of the sand and gravel deposits in the Copper Falls Formation. Horizontal hydraulic conductivity indicates the ability of an aquifer (in this case, the sand and gravel deposits) to transmit water. It is defined as the volume of water that will move in a unit of time under a unit hydraulic gradient at unit kinematic viscosity through a unit area at right angles to the direction of ground-water flow. Generally, horizontal hydraulic conductivity is directly proportional to well yield.

The horizontal hydraulic conductivity of the sand and gravel deposits estimated from drillers' specific-capacity tests ranges from about 2 to 700 ft/d. The median value is about 80 ft/d, which is indicative of a clean, somewhat compacted sand. These values are within the wide range of hydraulic-conductivity values given by Freeze and Cherry (1979, p. 29) for silty sand and clean sand.

Aquifer Characteristics of Precambrian Sandstone

Data from drillers' construction reports are available for 42 wells cased through the glacial deposits and open to the underlying sandstone. Most of these wells also are located in and around the populated area of Odanah (pl. 1). These wells range from 87 to 985 ft in depth and typically are open to the uppermost 10 to 50 ft of sandstone.

Specific-capacity data were analyzed to estimate the horizontal hydraulic conductivity of the sandstone. Hydraulic-conductivity values range from less than 1 to about 360 ft/d. The median value for the 42 wells is about 2 ft/d. According to Freeze and Cherry (1979, p. 29), this median value is at the upper end of the range of hydraulic conductivity for sandstone. Two factors may account for the apparent large values of horizontal hydraulic conductivity. First, most of these wells are only open to the upper 10 to 50 ft of sandstone. Second, the upper sandstone generally is fractured or broken up by weathering. Water can move at a faster rate through these openings than it can through unfractured rock. The 10 largest horizontal hydraulic-conductivity values were determined for wells open to an average of just 18 ft in the upper part of the sandstone. The 10 smallest values were determined for wells that are open to an average of about 60 ft of sandstone. This indicates that the horizontal hydraulic conductivity in the sandstone tends to decrease with depth.

Quality

Ground-water samples from 38 wells and 3 springs were collected in accordance with U.S. Geological Survey standard methods (U.S. Department of the Interior, 1977). The samples were analyzed at the USGS's National Water-Quality Laboratory in Arvada, Colo. Results of all chemical analyses are given in appendixes 2 and 3.

A total of 21 water samples were collected from 17 wells finished in sand and gravel deposits, and single samples were collected from each of 21 wells finished in Precambrian sandstone wells. Most of these samples (36 of 42) were collected from 1983 through 1987 to characterize recent ground-water quality on the Bad River Indian Reservation.

Concentrations of dissolved constituents most commonly found in Wisconsin ground water are summarized in table 1 for wells on the Bad River Indian Reservation. The principal dissolved constituents are calcium, magnesium, and bicarbonate. Median values of most constituents shown in table 1 are similar for water from both sand and gravel deposits and Precambrian sandstone. Exceptions are the somewhat larger median concentrations of sodium, sulfate, and chloride and somewhat smaller concentrations of manganese in water from wells finished in Precambrian sandstone (table 1). In general, the similarity in composition of water from both units is reasonable because sand and gravel wells derive water from deposits that lie directly on the Precambrian sandstone. Together, these two units make up the deep ground-water-flow system previously discussed and shown in figure 3. Median concentrations of constituents shown in table 1 are similar to those reported by Kammerer (1984) for a large area of northern Wisconsin that includes the Reservation. Median values reported by Kammerer for selected constituents are shown in parentheses in table 1. Median concentrations of sulfate, chloride, and dissolved solids in wells finished in sand and gravel in the larger area are 7.2, 2.5, and 150 mg/L, respectively (Kammerer, 1984, p. 38–39). Median concentrations of the same three constituents in Reservation sand and gravel wells are 6.6, 2.7, and 155 mg/L, respectively (table 1). Median concentrations of sulfate, chloride, and dissolved solids in water from wells finished in Precambrian sandstone in the larger area are 22, 16, and 244 mg/L, respectively. These median values are almost identical to those of Reservation well water, with the exception of dissolved-solids concentrations in water from Precambrian sandstone wells. The median concentration of dissolved solids in Precambrian sandstone wells on the Reservation is only 157 mg/L.

Table 1. Summary of dissolved chemical constituents in ground-water samples

[All units are milligrams per liter unless otherwise indicated. Numbers in parentheses represent concentrations or values from summary of water-quality data by Kammerer (1984). µS/cm, microsiemens per centimeter at 25°C; $CaCO_3$, calcium carbonate; °C, degrees Celsius; mg/L, milligrams per liter]

	No. of samples	Minimum concentration or value	Maximum concentration or value	Median concentration or value
	Wells open to sand and gravel deposits			
Specific conductance (µS/cm)	16	95	510	250
pH (standard units)	17	7.5	10.0	8.3
Hardness (as $CaCO_3$)	13	49	200	99
Calcium	11	14	44	24
Magnesium	10	3.5	23	8.8
Sodium	6	1.9	120	9.2
Potassium	6	0.6	6.5	1.3
Alkalinity (as $CaCO_3$)	17	52	220	96
Sulfate	16	.7	21	6.6 (7.2)
Chloride	17	.7	100	2.7 (2.5)
Dissolved solids (at 180°C)	17	74	294	155 (150)
Iron (mg/L)	12	<10	2,300	30 (100)
Manganese (mg/L)	12	1	98	46 (30)
	Wells open to Precambrian sandstone			
Specific conductance (µS/cm)	21	200	560	275
pH (standard units)	21	7.5	9.4	8.1
Hardness (as $CaCO_3$)	13	6	140	90
Calcium	13	2.1	38	23
Magnesium	13	.3	12	6.5
Sodium	3	21	29	26
Potassium	3	4.1	5.8	4.7
Alkalinity (as $CaCO_3$)	21	63	170	84
Sulfate	21	4.4	29	19 (22)
Chloride	21	.6	100	17 (16)
Dissolved solids (at 180°C)	21	117	307	157 (244)
Iron (mg/L)	12	<10	1,100	80 (100)
Manganese (mg/L)	12	<1	41	3 (40)

Water samples were analyzed for many constituents that have maximum permissible and recommended concentrations specified in Wisconsin's drinking-water standards for public-water supplies (Wisconsin Department of Natural Resources, 1978). Wisconsin's drinking-water standards are summarized in table 2. Analyses of ground-water samples collected during this study indicate no health-related problems from inorganic constituents. This is best shown by comparing analysis results in appendixes 2 and 3 to the drinking-water standards in table 2. The trace metal lead exceeded the primary health standard of 50 µg/L (table 2) in water from two wells. Water from these wells, AS-38 and AS-288 in appendix 3, had lead concentrations of 64 and 98 µg/L, respectively. Well AS-38 is an old unused well; AS-288 is an active domestic-supply well. Water from well AS-38 also had a zinc concentration of 11,000 µg/L, which exceeds the aesthetic standard of 5,000 µg/L. The source of these metals may be dissolution of these metals in the plumbing pipes. Metals may dissolve in well water in contact with pipes for long periods of time while the well is unused.

The predominant ground-water-quality problem on the Reservation is large concentrations of iron and manganese. Concentrations of these metals that exceed

Table 2. Summary of Wisconsin's drinking-water standards
[From Wisconsin Department of Natural Resources, 1978. --, standard not applicable]

Constituent	[Maximum recommended total or dissolved concentration. All concentrations in milligrams per liter (micrograms per liter in parentheses) unless otherwise indicated] Primary (health) standard		Secondary (aesthetic) standard	
Arsenic	0.05	(50)	--	--
Barium	1	(1,000)	--	--
Cadmium	.01	(10)	--	--
Chromium	.05	(50)	--	--
Fluoride	2.2	--	--	--
Lead	.05	(50)	--	--
Mercury	.002	(2)	--	--
Nitrate (as N)	10	--	--	--
Selenium	.01	(10)	--	--
Silver	.05	(50)	--	--
Chloride	--	--	250	--
Color	--	--	15 units[1]	--
Foaming agents (MBAS)	--	--	0.5	--
Hydrogen sulfide	--	--	not detectable	
Iron	--	--	.3	(300)
Manganese	--	--	.05	(50)
Odor	--	--	3	threshold number
Sulfate	--	--	250	--
Total residue	--	--	500	--
Zinc	--	--	5	(5,000)

[1]Platinum cobalt scale.

the Wisconsin secondary (aesthetic) drinking-water standards may cause objectionable taste and staining of laundry and plumbing fixtures. Dissolved and total-recoverable (dissolved plus particulate) concentrations were determined in water from 36 wells on the Reservation (appendix 3). Water samples from 5 wells had total-recoverable iron concentrations that exceeded 500 µg/L, and 8 water samples from 7 wells exceeded the secondary drinking-water standard of 50 µg/L for total-recoverable manganese. Kammerer (1984) found that one-fourth to one-half of all water samples collected from wells in northern Wisconsin, including the Reservation, had iron and manganese concentrations that exceeded Wisconsin's drinking-water standards.

SURFACE WATER

The Reservation is named after the Bad River, which flows northward through the middle of the Reservation. About three-quarters of the Reservation lies within the Bad River basin. The largest tributary to the Bad River is the White River, which empties into the Bad River on the west edge of the village of Odanah (pl. 1). Smaller streams, such as Morrison and Denomie Creeks in the northeast, and Beartrap Creek and the Kakagon River in the northwest, drain directly into Lake Superior (pl. 1).

Streamflow

Streamflow has been measured continuously at one of two gaging stations on the Bad River for much of the period from 1914 to the present. The principal station, the Bad River near Odanah (station number 04027000), is located about 8 mi south of the village of Odanah (pl. 1). This station has a drainage basin of 597

Table 3. Daily flow-duration characteristics for the Bad River near Odanah (station number 04027000)
[Based on 1914–91 period of record]

	Discharge, in cubic feet per second, which is equaled or exceeded for indicated percentage of time										
Percentage of time	95	90	80	70	60	50	40	30	20	10	5
Discharge	99	117	149	184	226	279	362	491	762	1,505	2,380

mi^2; about 55 mi^2 of this area lies within the Reservation. Streamflow was measured at this station from 1914 through 1922 and from 1948 through the present. This station was discontinued, and streamflow was measured as the Bad River at Odanah (station number 04027595) from 1978 through 1988 to include more of the total Bad River basin. The drainage area at this station is 990 mi^2, which includes about 140 mi^2 of Reservation land. Operation of this station (Bad River at Odanah) was discontinued after 1987 because backwater effects from nearby Lake Superior caused the streamflow record to be unsatisfactory. Operation of the gaging station was returned to the original location (Bad River near Odanah) in 1987.

The average daily discharge for the Bad River near Odanah (location number 04027000) for the period of record ending September, 1988 is 622 ft^3/s. The maximum instantaneous discharge ever recorded was 27,700 ft^3/s on April 24, 1960. The peak flow of this same flood downstream at the Bad River at Odanah (station number 04027595) was estimated to be 45,600 ft^3/s as determined indirectly from high-water marks. The minimum instantaneous discharge for the Bad River near Odanah was 34 ft^3/s on November 8, 1976, during fall freezeup.

Flow-duration characteristics indicate the percentage of time that a specified streamflow discharge is equaled or exceeded during the period of record. For example, table 3 shows that streamflow in the Bad River near Odanah equals or exceeds 762 ft^3/s 20 percent of the time. However, this does not mean that flow will exceed 762 ft^3/s for 20 percent of each year or even within a specific 10-year period.

Knowledge of flow characteristics, particularly low flow, is useful when making decisions regarding multiple use of a stream resource. For example, knowledge of low flow in a stream is necessary when the maintenance of fish habitat is weighed against hydropower production or against dilution of wastes. Flood and low-flow frequency characteristics were estimated from mean-daily discharge values for the period of record at Bad River near Odanah (site 04027000). The recurrence intervals were determined using a log-Pearson Type III distribution. Computed discharges with their associated recurrence intervals are shown in table 4. Table 4 shows, for example, that the average time between floods with a peak flow of 11,000 ft^3/s is 5 years. The low-flow frequency values in table 4 show that the average time interval between a period of at least 7 consecutive days having a maximum discharge of 104 ft^3/s is 2 years. For comparison, table 3 shows that flow equals or exceeds 104 ft^3/s almost 95 percent of the time.

Quality

Water samples were collected from 12 sites on 10 streams during July and August 1983–87. These samples were collected during base-flow conditions when streamflow is derived largely from ground-water discharge. The samples were analyzed for common inorganic constituents, nutrients, trace metals, and organic-carbon concentrations. Analysis results are shown in appendix 4.

Concentrations of common chemical constituents in surface water are somewhat lower than concentrations in ground water. For example, the median total-dissolved solids concentration in 19 stream-water samples is 110 mg/L and in ground-water samples from Reservation wells is about 155 mg/L.

The backwater sloughs and lakes near the mouths of the Kakagon and Bad Rivers provide habitat for extensive stands of wild rice. Wild rice depends on large nutrient concentrations in bottom material for growth. Samples of bottom material were collected at eight sites on the Kakagon slough (pl. 1) during July and August 1986 and 1987 and analyzed for concentrations of nitrogen and phosphorus. Results of these analyses are presented in appendix 5. Water samples also were collected from open water in two backwater lakes—Honest John Lake and the Bad River Slough—and from Lake Superior (pl. 1) during July 1986. These samples were analyzed for common chemical constituents. Results of these three analyses (appendix 5) suggest the dissolved-solids concentration in water from these lakes is approximately half that of ground water. This indicates that precipitation, which has a low concentration of dissolved solids, is the source of much of the water in these lakes.

Water-quality samples have been collected at the Bad River near Odanah gaging station (station number

Table 4. Flood and low-flow frequency characteristics for the Bad River near Odanah (station number 04027000)
[Based on 1914–91 period of record]

Flood frequency

	Peak discharge, in cubic feet per second, for indicated recurrence interval, in years:					
	2	5	10	25	50	100
Discharge	7,730	11,000	13,400	16,600	19,100	21,900

Low-flow frequency

Consecutive-day period	Discharge, in cubic feet per second, for indicated recurrence interval, in years: 2 years	5 years	10 years	20 years
7	104	79	68	59
14	112	84	71	62
30	124	94	80	70
60	146	110	95	83
90	165	123	106	94

04027000) since October 1964. In October 1974, this station became part of the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN). This nationwide program established monthly sampling at gaging stations on major rivers to provide consistent and continuous monitoring of stream-water quality. Water samples at the Bad River gaging station and other NASQAN stations are analyzed for common chemical constituents, nutrients, and selected trace-metal concentrations. NASQAN water-quality data are available for the Bad River near Odanah gaging station for the periods October 1974 to January 1978, and from October 1987 to October 1993. The NASQAN sampling site was moved downstream to the Bad River at Odanah (station number 04027595, pl. 1) from February 1978 through September 1987, to represent a larger part of the drainage basin.

All water-quality data for these two NASQAN stations are accessible from the National Water Information System (NWIS) data base at the U.S. Geological Survey District office in Madison, Wis. These data also are available in annual Water Resources Data reports published by the District office in Madison, Wis.

SUMMARY

The Bad River Indian Reservation is located along the Lake Superior shore in northwestern Wisconsin. The area is underlain by unconsolidated glacial deposits that overlie basalt lava flows and Precambrian sandstone. Glacial deposits exceed 1,000 ft in thickness in a small area along the eastern edge of the Reservation. Bedrock is exposed at several locations along streambeds.

All community and domestic water supplies on the Reservation are obtained from wells finished in buried glacial sand and gravel deposits or in Precambrian sandstone. Wells typically are about 150 to 250 ft deep. However, two community-supply wells along the eastern edge of the Reservation are more than 950 ft deep. The sand and gravel deposits and Precambrian sandstone that provide water to wells are buried beneath nearly impermeable glacial-lake clay deposits throughout most of the Reservation. The buried sand and gravel deposits and the upper 50 ft of Precambrian sandstone together form a confined ground-water-flow system underlying the Reservation. Several wells in and around the village of Odanah that are finished in these deposits flow above land surface as is common with wells open to aquifers in a confined ground-water system.

Drillers' specific-capacity data were used to estimate the horizontal hydraulic conductivity of the aquifer. The horizontal hydraulic conductivity of the sand and gravel deposits ranges from about 2 to 700 ft/d, with a median value of about 80 ft/d. Estimated horizontal hydraulic conductivity of the Precambrian sandstone ranges from less than 1 to about 360 ft/d, with a median of about 2 ft/d. Yields of 5 to 10 gal/min for domestic supply appear to be available from sand and gravel and sandstone throughout the Reservation. Small community-supply yields of 25 to 90 gal/min appear to be available from wells finished in Precambrian sandstone.

Concentrations of dissolved chemical constituents in water from the sand and gravel are almost identical to those in water from the Precambrian sandstone. Concentrations of individual constituents, in turn, are similar to those found in these two rock types throughout northern Wisconsin. The principal dissolved constituents are calcium, magnesium, and bicarbonate; minor concentrations of sodium, sulfate, chloride, and fluoride are common. Dissolved-solids concentrations typically range from about 150 to 250 mg/L. Concentrations of dissolved iron and manganese exceed Wisconsin aesthetic drinking-water standards of 300 and 50 µg/L, respectively, in about 10 to 20 percent of all ground-water samples. The largest nitrate concentration was about 0.30 mg/L; most nitrate concentrations (34 of 38 samples) were less than 0.10 mg/L (the Wisconsin primary drinking-water standard for nitrate is 10 mg/L).

Flow-duration, flood, and low-flow frequency characteristics of the Bad River were estimated using streamflow data collected at the gaging station near Odanah. Surface-water quality in small streams and in the Bad River is similar to ground-water quality. Calcium, magnesium, and bicarbonate are the principal dissolved constituents. However, concentrations of dissolved solids in stream water range from about 50 to 150 mg/L, somewhat less than those in ground water. NASQAN water-quality data are available for the Bad River and provide continuous baseline water-quality data since 1974.

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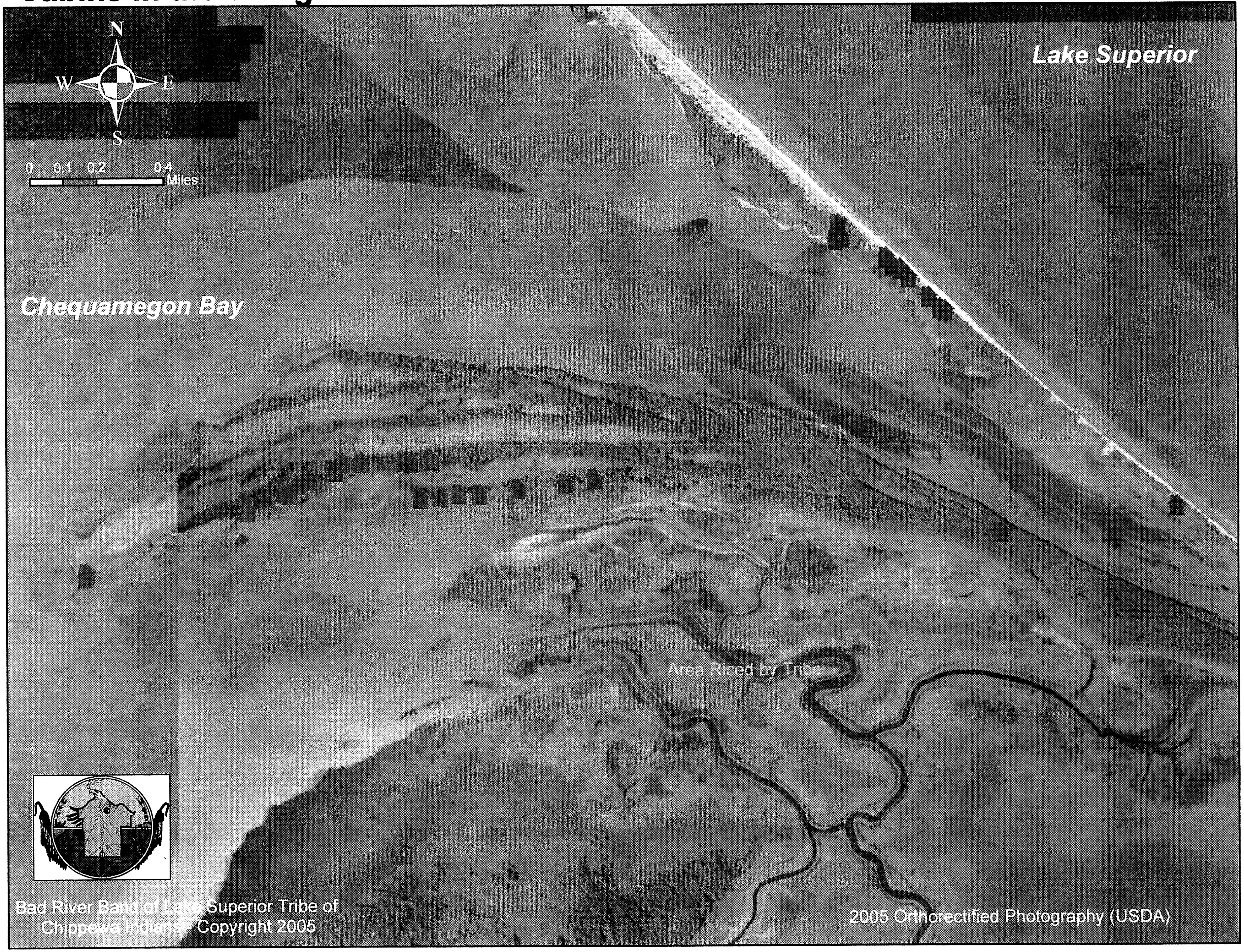
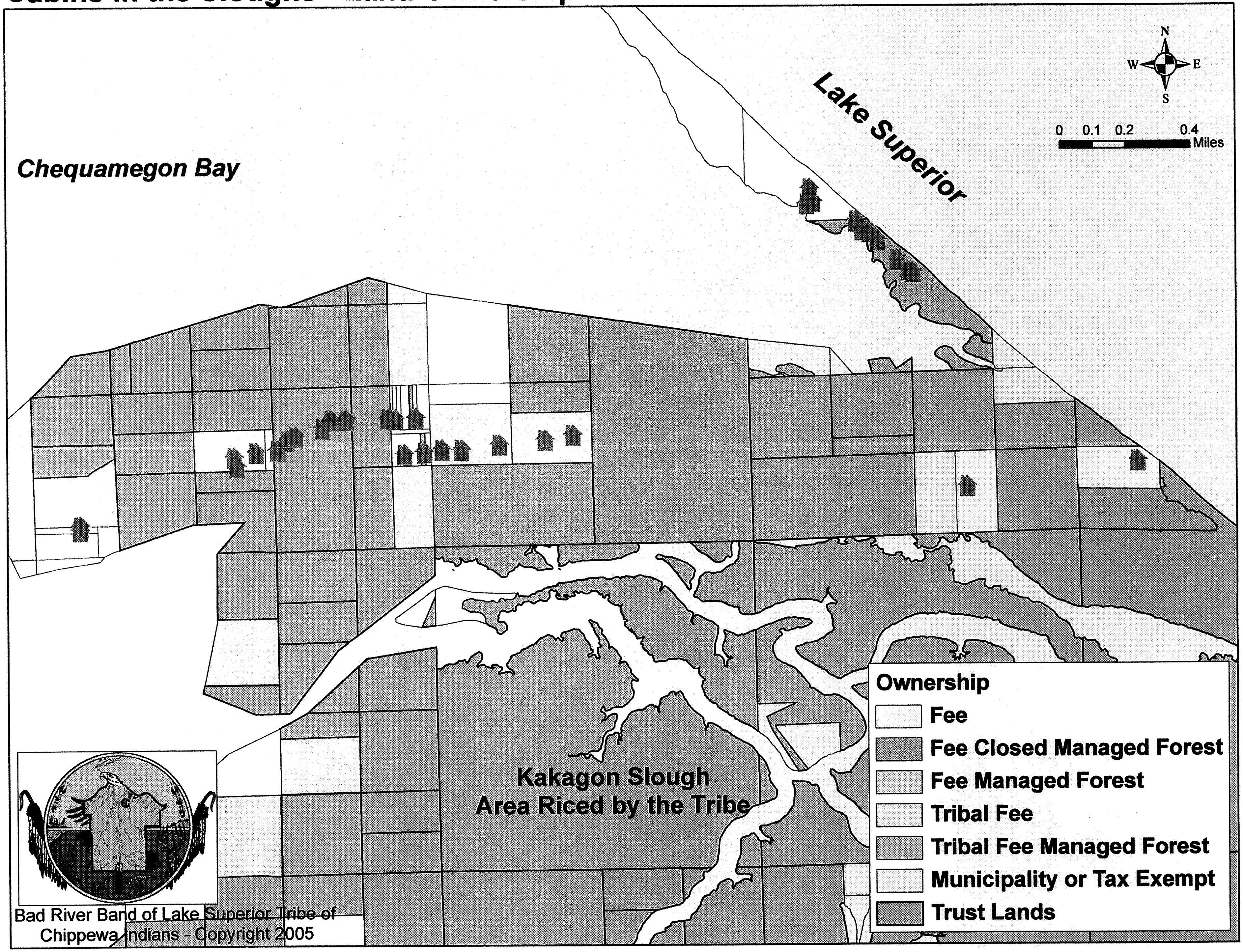
APPENDIXES 1-5

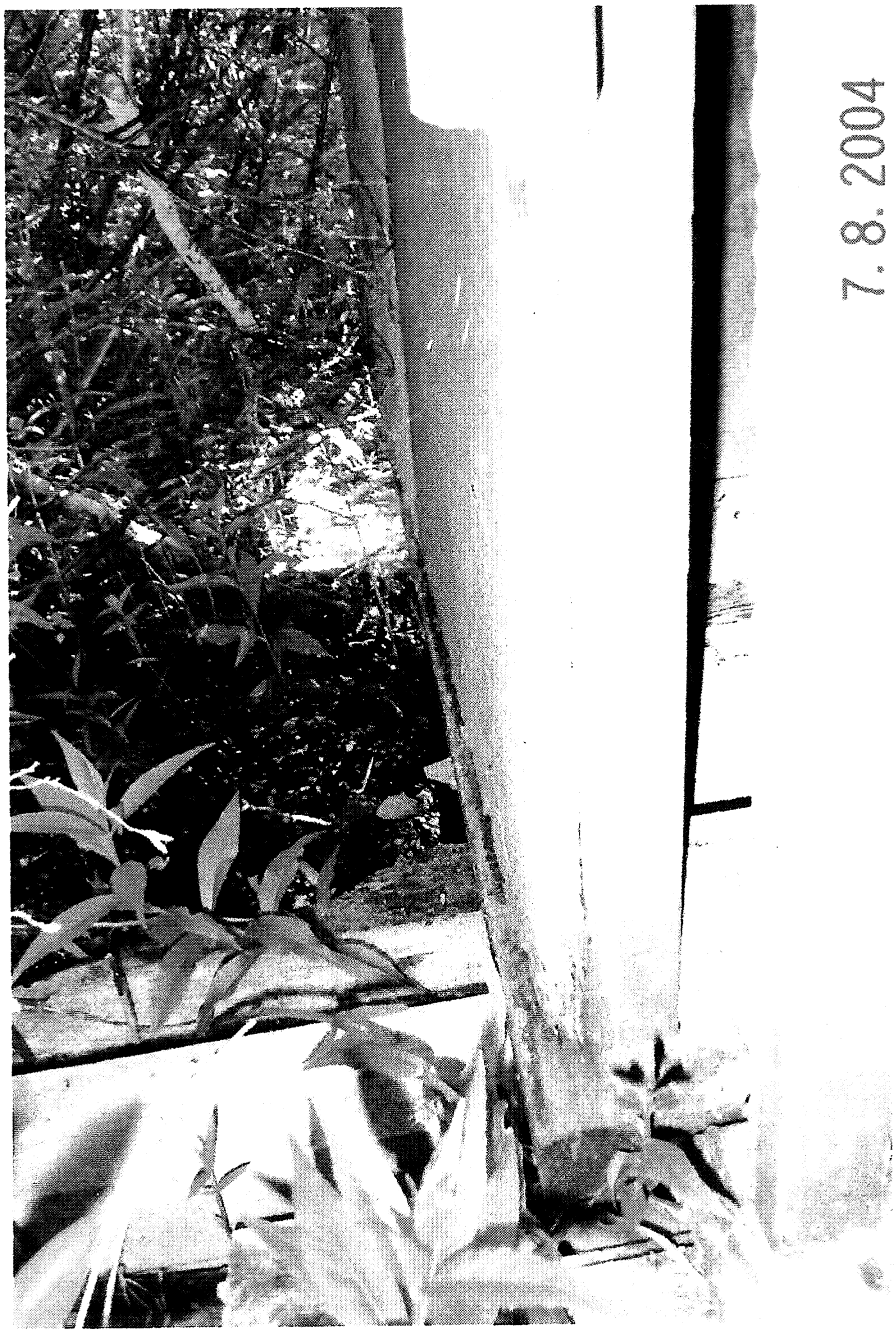
Cabins in the Sloughs



Cabins in the Sloughs - Land Ownership Records



Cabin trash pile located less than 10 feet from wetland. Pile contains construction debris, metal tanks, carpet, pieces of furniture and plastic waste.



Outhouse located within edge of wetland.
Water and wetland vegetation visible behind and directly under outhouse.

Trash pile behind one of the cabins. Pile is located in a wetland and contains barrels, crates, a metal bedspring, other metal objects and plastic waste.